E & A

Mosquito News

Published Quarterly

by the

AMERICAN MOSQUITO CONTROL ASSOCIATION, INC.

VOLUME 20 DECEMBER, 1960 NUMBER 4

27 JAN 1961
U.S.A. 146
SERIAL
SEPARATE

CONTENTS

ARTICLES PAGE

Stratification of Some Prairie and Forest Mosquitoes in the Lower Air
L. Burgess and W. O. Haufe 341
A Comparison of Four Different Adult Diets for the Routine Laboratory Rearing of *Aedes aegypti* (L.) ..... J. N. Liles, R. Meola, W. L. Jones and D. M. DeLong 347
Survey of Log Pond Mosquitoes in Douglas County, Oregon, During 1956
F. C. Harmston, L. S. Miller and R. A. McHugh 351
A Note on the Bionomics of *Aedes atropalpus* (Coquillett)
L. G. Strom, H. A. Trevino and E. G. Campos 354
The Mosquito Fauna of Kohat-Hangu Valley, West Pakistan ..... M. Qutubuddin 355
Effectiveness of Granular Insecticides Against Eye Gnats and Mosquitoes as Affected by Toxicant Concentration ..... M. S. Mulla 362
Susceptibility of *Anopheles albimanus* to Primate and Avian Malarias ..... Don E. Eyles 368
Control of *Culicoides* (Diptera: Heleidae) in Small Plots on Cape Cod, Massachusetts
W. J. Wall, Jr. 371
Longevity of Insecticides in Soil as Tested Against the Eye Gnat *Hippelates collusor*
M. S. Mulla 376
Control Measures for Log Pond Mosquitoes in Douglas County, Oregon
L. J. Ogden, L. S. Miller and J. V. Smith 380

OPERATIONAL AND SCIENTIFIC NOTES

Preservation of Mosquito Pupae by the Freeze-Drying Technique ..... J. M. White 384
An Escape-Proof Mosquito Egg Harvester ..... D. J. Reynolds 384
On the Different Types of Resistance ..... L. Vargas 386
The Volumes in a Horizontal Cylindrical Tank at Various Depths ..... H. F. Gray 387
Dieldrin Cement Briquettes in Controlling *Aedes aegypti* in Fire Barrels
B. R. Evans and E. J. Fink 388

ASSOCIATION NEWS

A History of the American Mosquito Control Association 390
Program—Annual Meeting, January 30-February 2 402

NEWS AND NOTES 406

BIBLIOGRAPHY 412

LIST OF ADVERTISERS 389

ADVERTISING RATES XIII

Annual Meeting, January 31–February 2, 1961, Disneyland, California

MOSQUITO NEWS

Official Publication of the American Mosquito Control Association, Inc.

EDITORIAL STAFF

DONALD L. COLLINS, *Editor*, New York State Education Bldg., Albany 1, New York

R. D. GLASGOW, *Consulting Editor*, New York State Education Bldg., Albany 1, New York

MRS. MARGARET G. SLATER, *Assistant to Editor*, New York State Education Bldg., Albany 1, New York

HELEN SOLLERS, *Associate Editor* (Bibliography), Plant Pest Control Div., Agric. Res. Service, U. S. Dept. of Agriculture, Washington 25, D. C.

MRS. HELEN LOUISE DURKEE, *Associate Editor* (Reviews and Abstracts), 113 Sonora Avenue, Danville, California

AUSTIN W. MORRILL, JR., *Associate Editor* (News and Notes), DD-111, District Public Works Office, Hq. 12th Naval District, San Bruno, California

W. C. MCDUFFIE, *Associate Editor* (Articles), USDA, Entomology Research Division, Plant Industry Station, Beltsville, Maryland

---

F. P. CREADON, Advertising Manager, Desplaines Valley Mosquito Abatement Dist., 8130 Ogden Ave., Lyons, Ill.

T. G. Raley, Executive Secretary, P. O. Box 278, Selma, Calif.

L. W. SMITH, Treasurer, Parsonage Road, Metuchen, N. J.

WILLIAM M. THOM, Asst. Treasurer, Parsonage Road, Metuchen, N. J.

Published by
AMERICAN MOSQUITO CONTROL ASSOCIATION, INC.

Printed by
Boyd Printing Company, Inc., Albany, N. Y.

A quarterly journal published on the 20th of March, June, September and December. Devoted to the improvement and the sound extension of mosquito control and related work as a vital public health service.

SUBSCRIPTION RATES

$5.00 per Year (U. S. money), Single Copies, $1.75
Mailed without charge to members of the Association.

MEMBERSHIP DUES—$5.00

PUBLICATION OFFICE: American Mosquito Control Association, Inc., Room 461, State Education Bldg., Albany 1, N. Y. GENERAL OFFICE: P. O. Box 278, Selma, Calif. BUSINESS OFFICE: P. O. Box 346, Metuchen, N. J. *Second class postage* paid at Albany, N. Y.

BUSINESS COMMUNICATIONS

Communications relating to editorial matters and manuscripts submitted for publication in MOSQUITO NEWS should be addressed to Donald L. Collins, Editor, MOSQUITO NEWS, New York State Museum, Albany 1, New York.

Communications relating to advertising space should be addressed to F. P. Creadon, Advertising Manager, Desplaines Valley Mosquito Abatement Dist., 8130 Ogden Ave., Lyons, Ill.

Communications relating to subscriptions to MOSQUITO NEWS, Membership in the American Mosquito Control Association, and other association matters should be addressed to T. G. Raley, Executive Secretary, American Mosquito Control Association, P. O. Box 278, Selma, Calif. Changes of address should reach the Secretary before the first of the month of publication.

Copyright 1960 by
THE AMERICAN MOSQUITO CONTROL ASSOCIATION, INC.

ARTICLES

STRATIFICATION OF SOME PRAIRIE AND FOREST MOSQUITOES IN THE LOWER AIR [1]

L. BURGESS [2] AND W. O. HAUFE [3]

The vertical stratification of mosquitoes on the western prairies and in the eastern forests of Canada has been studied recently with traps operated at five, twenty-five and fifty feet above the ground. This work was undertaken to provide information for those planning control measures against adult mosquitoes, and to aid in the interpretation of host-preference, biting rate and abundance studies.

Of the stratification studies reported in the literature, most deal with mosquitoes in forests, although MacCreary (1941) gives an account of trapping conducted from a light-tower in the suburbs of a city and from one in the midst of extensive salt-marshes. In both areas he found that catches in the traps high above ground were small in comparison with those in traps near the ground. In forested areas, however, Haddow *et al.* (1947), Deane *et al.* (1953), Snow (1955), Snow and Pickard (1957), and Love and Smith (1958) have shown that while some mosquitoes are most abundant near the forest floor, others are most abundant at various levels within the forest. Bates (1949) suggests that stratification of mosquitoes within the forest may be influenced by vertical gradients of temperature, humidity and light, behaviour associated with mating and oviposition, and the location of larval habitats. Love and Smith (1958) feel that the location of hosts might also be an important factor.

MATERIALS AND METHODS. Traps possessing a moving striped pattern to attract mosquitoes (Haufe and Burgess 1960) were suspended at heights of 5, 25 and 50 feet on a prefabricated metal tower. In the early morning and late afternoon of each day, the traps were lowered to the ground with rope and pulleys and the catches were removed. The traps operated continuously and the catches were automatically divided into hourly samples. The traps were not illuminated at night. This avoided the attraction of mosquitoes from one level to another by light sources.

The trapping site on the prairie was a field of open flat grassland near Brooks, Alberta (Fig. 1), where the traps were operated from June 13 to September 14, 1956. Catches from August 5, 6, 23 and 24 were excluded because of failure of the sample-separating mechanisms.

In the forest, the tower was set up in a marshy area near Marmora, Ontario, and the traps were operated from May 31 to July 27, 1957. The predominant trees were white ash and American elm. There was a luxuriant ground cover of grass and herbs, three to four feet high. Above this, willows and alders extended to a height of 20 to 25 feet. The general tree-top level lay just even with the 50-foot trap, although a few trees extended beyond this height. Foliage was dense up to the 25-foot level. Above this it was

---

[1] Contribution of the Entomology Laboratory, Research Branch, Canada Department of Agriculture, P. O. Box 248, Guelph, Ontario, and the Veterinary-Medical Entomology Section, Canada Agriculture Research Station, Lethbridge, Alberta.

[2] Entomology Laboratory, Guelph, Ontario.

[3] Canada Agriculture Research Station, Lethbridge, Alberta.

thin and scattered, with sizeable openings between the tops of the larger trees.

Positive identification of the trapped mosquitoes could usually be made. Some difficulty did arise in the separation of damaged specimens of *Aedes dorsalis* (Meigen) from those of *Aedes campestris* Dyar and Knab. The catches plotted as *A. dorsalis* in Fig. 2 may thus include some *A. campestris*. A few males of *Aedes melanimon* Dyar were caught (Burgess 1957) and it is possible that females of this species were also mistaken for *A. dorsalis*. Of the forest-inhabiting mosquitoes, *Aedes stimulans* (Walker) could not be separated with certainty from *Aedes fitchii* (Felt and Young).

In the graphical presentation of the data (Fig. 2 and Fig. 3) the total hourly catches of each species are plotted with reference to the time of the hourly catch during which sunset occurred, rather than with reference to clock time. This procedure was necessitated because of the change in the actual time of sunset during the trapping studies.

STRATIFICATION OVER THE PRAIRIE. Of the fifteen species caught on the prairie, females of *Aedes dorsalis* (Meigen), *Aedes vexans* (Meigen), *Aedes spencerii* (Theobald), *Culiseta inornata* (Williston), and *Culex tarsalis* Coquillett, were caught abundantly (Fig. 2). *Culiseta inornata* was taken only in the traps at the 5-foot and 25-foot levels. On a night not included in the study, one specimen was taken at the 50-foot level. Each of the four other species was caught at all three levels. For each species, the total numbers caught decreased with increased height of the trap above the ground. Of the total number of female mosquitoes caught, 78 percent were taken at the 5-foot level, 13 percent at the 25-foot level and 9 percent at the 50-foot level.

The catches of males were small. Except for *A. vexans*, the density of males decreased as height above ground increased. *A. vexans* males were caught in relatively large numbers in the 50-foot trap and never in conjunction with females at this

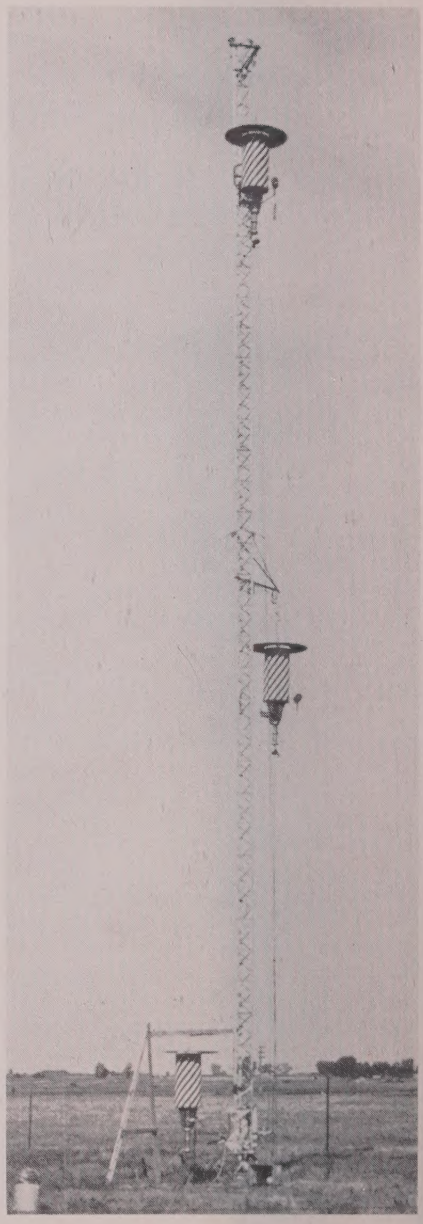


FIG. 1.—Mosquito traps suspended from a tower at heights of 5, 25 and 50 feet above the prairie near Brooks, Alberta.

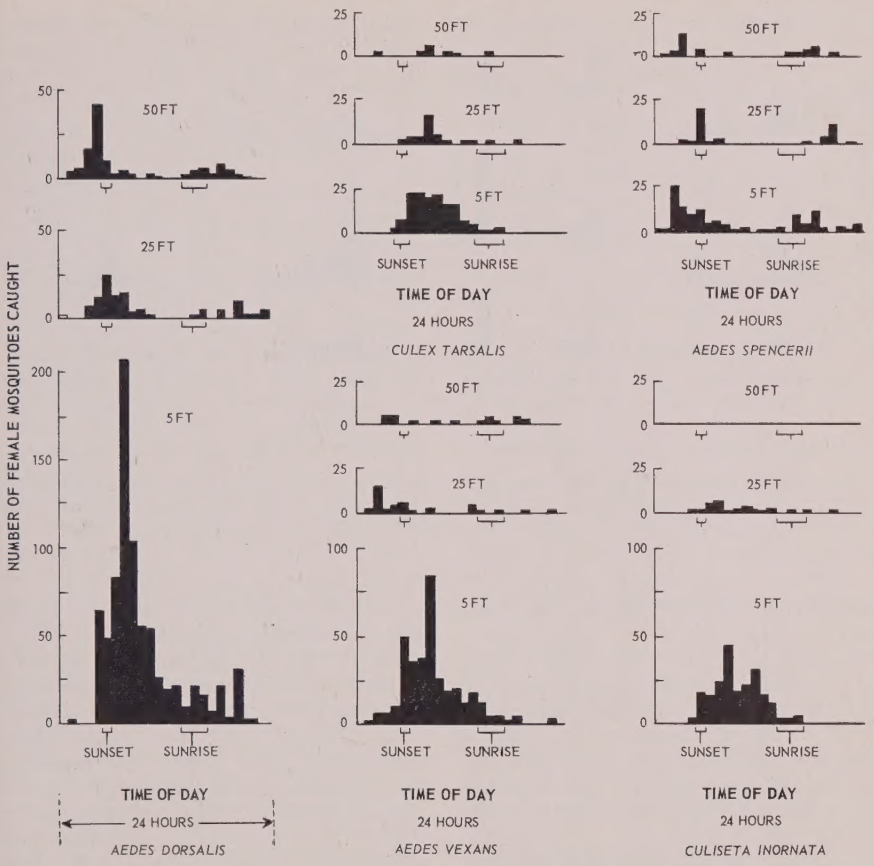


FIG. 2.—The stratification and daily activity of some prairie mosquitoes as shown by the total hourly catches taken in traps at 3 heights above the prairie at Brooks, Alberta, from June 13 to September 14 (exclusive of August 5, 6, 23 and 24). All catches are plotted with reference to the time of sunset.

height. In trapping at the same location in the previous year, 28 males of this species were caught in one hour at the 50-foot level.

STRATIFICATION IN THE FOREST. Females of *Mansonia perturbans* (Walker), *Culiseta morsitans* (Theobald), *Aedes stimulans* (Walker), and *Aedes punctor* (Kirby) were caught in abundance in the traps in the forest. Each species was caught at the three levels (Fig. 3). *A. punctor* was caught in about equal numbers in each of the lower two traps and in smaller numbers in the 50-foot trap, while each of the other three species was caught in largest numbers in the trap at the 25-foot level. Twenty-nine percent of the total catch of female mosquitoes was taken at the 5-foot level, 53 percent at the 25-foot level and 18 percent at the 50-foot level. Sharp increases in the catches of *A. stimulans* and *A. punctor* were noted in the late afternoon and early morning. These increases correspond to the times when the traps were serviced, and thus may consist partially of mosquitoes attracted to the observers. Corresponding increases, however, were barely apparent in the catches of *M.*

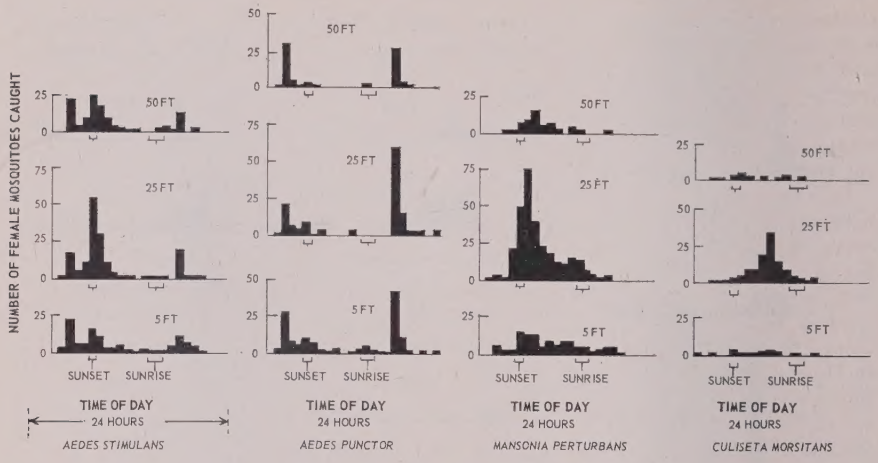


FIG. 3.—The stratification and daily activity of some forest mosquitoes as shown by the total hourly catches taken in traps at 3 heights above the ground in the forest at Marmora, Ontario, from May 31 to July 27, 1957. All catches are plotted with reference to the time of sunset.

perturbans, a species that also bites man readily.

Catches of males were small. Males of *A. stimulans* and *A. punctor* were caught in about equal numbers at all levels. Over 70 percent of the males of *Culiseta morsitans* were caught at the 25-foot level. Only five male *M. perturbans* were taken, all of these at the two upper levels.

GENERAL OBSERVATIONS. In both locations, appreciable catches of mosquitoes were taken only in the period from late afternoon to mid-morning. *Culiseta inornata, Culiseta morsitans* and *Culex tarsalis* were most active during darkness. The largest numbers of *A. vexans* and *M. perturbans* were obtained soon after sunset, but the numbers caught decreased with the onset of darkness. *A. spencerii* and *A. punctor* were almost completely inactive during darkness, their major activity occurring just before sunset and just after sunrise. The largest catches of *A. dorsalis* were taken after sunset in the lower trap, at sunset in the trap at the 25-foot level and before sunset in the top trap. The activity of *A. stimulans* reached its maximum at sunset, with secondary peaks occurring several hours prior to sunset and several hours after sunrise.

On the prairie, large catches of mosquitoes were usually associated with evenings when it was warm and the winds were light. In the forest, large catches were likewise associated with warm evenings, but the effect of winds appeared to be reduced by the density of the forest cover.

A few mosquitoes that were engorged with blood were taken in each of the traps at both locations. A report that includes the identification of the blood meals will be published.

DISCUSSION. In both prairie and forest locations, the vertical distribution of female mosquitoes was similar to that found in comparable areas by previous workers. Over the prairie there was a general decrease in the density of all species as height above ground increased, whereas in the forest, some mosquitoes were found to be more abundant well up in the foliage than near the ground.

The observed differences in stratification patterns in the two areas are possibly manifestations of basic behavioural differences in the species involved. Behavioural differences of considerable magnitude

existed even between the species in one area, e.g., the stratification of *A. punctor* and that of *Culiseta morsitans* in the forest. Love and Smith (1958) found that the different species present in one single wooded area exhibited four different types of stratification.

Differences in the nature of the two habitats probably also contribute to differences in the patterns of stratification between the two areas. Both the work of MacCreary (1941) and our present study, showed that the density of female *A. vexans* decreased with increased height in the open; while in the woods, Love and Smith (1958) caught more female *A. vexans* at the 25-foot level than at the 50-foot level or a 6-foot level. Certainly, temperature, humidity and light gradients, air movement, and the location of hosts are likely to differ between forest and prairie. In the forest, a mosquito flying at any level below the tree-tops remains in close proximity to solid, visible objects. Potential resting sites are thus abundant well above the ground. Over the prairie, however, a mosquito must descend to the ground when it becomes inactive, unless it happens to be carried aloft by rising air currents. Likewise, if birds are acceptable hosts, the forest-dwelling mosquito may also obtain a blood meal without descending, although it must later descend to oviposit. The physiological condition of a mosquito can thus conceivably affect the height at which it flies.

The daily periodicity in the activity of the various species as indicated by the size of the hourly catches, contributes little new information to that already documented by Carpenter and LaCasse (1955), Rempel (1953), Horsfall (1955), Matheson (1944), McLintock (1944), and others.

Comparisons of the times of activity of a species at the three elevations would be desirable. Simultaneous catches from the three traps at a particular time, necessary if such comparisons are to be valid, were usually small, however. Fig. 2 and Fig. 3 represent data summed from many days. Nevertheless, several general relationships can be observed. On the prairie, fewer mosquitoes were taken at the higher levels after darkness than were taken at these levels at or just before sunset. This may indicate a relationship between the height of voluntary flight and a perception of a ground pattern, or may be a negative phototactic response to light from the sky by nocturnal species. In the forest, the times of peaks in catch size at the different levels coincided closely, and there did not appear to be an upwards and downwards migration of mosquitoes at different times of the day. Snow and Pickard (1957) found *Mansonia perturbans* to migrate upwards into the foliage at dusk and downwards at dawn in the woods in Tennessee.

The capture of relatively large numbers of *A. vexans* males at the 50-foot level over the prairie is interesting. Possibly the males had formed a mating swarm at this height, although females were never caught in conjunction with them. MacCreary (1941) and Blakeslee, Axtell and Johnston (1959) reported substantial catches of *A. vexans* males in the upper trap of a series.

The present studies have shown that a considerable number of mosquitoes can be expected to occur at heights of 25–50 feet above the prairie, and that, in the forest, even a preponderance of the population may be found at levels well up in the foliage. Therefore, studies of the adult mosquitoes in a particular area will be incomplete if attention is paid only to the mosquitoes that are within the reach of an observer on the ground. When insecticidal control measures against adult mosquitoes are being planned, the desirability of reaching also the mosquitoes that are at the higher levels should not be overlooked.

Summary. Catches of mosquitoes in traps operated at elevations of 5, 25 and 50 feet are reported for a prairie and forest location.

Females of *Aedes dorsalis, Aedes vexans, Aedes spencerii, Culiseta inornata* and *Culex tarsalis* were caught in appreciable numbers over the prairie. The density of each species decreased with increased height above ground. All species were

well represented in the catches of each trap, except for *Culiseta inornata,* of which only one specimen was ever taken in the trap at the 50-foot level. Male mosquitoes showed a distribution similar to that of the females, except that the majority of the males of *A. vexans* were caught at the 50-foot level.

Females of *Aedes punctor, Mansonia perturbans, Aedes stimulans* and *Culiseta morsitans* were caught in appreciable numbers in the forest. The latter three species were caught most abundantly in the trap at the 25-foot level, while *A. punctor* was caught in about equal numbers in each of the lower two traps, and in smaller numbers in the 50-foot trap. Catches of males were small.

ACKNOWLEDGMENTS

The authors acknowledge with thanks the co-operation and assistance of Mr. J. A. Shemanchuk, Canada Department of Agriculture Research Station, Lethbridge, Alberta, and the technical assistance of Mr. E. J. Duff, Entomology Research Institute, Ottawa, Ontario. Sincere thanks are extended to Mr. P. D. Hargrave, Superintendent, Provincial Horticultural Station, Brooks, Alberta, who generously provided many facilities for the studies on the prairie. Thanks are also extended to Dr. L. Davies and Mr. J. A. Downes, Entomology Research Institute, Ottawa, Ontario, who kindly read the manuscript and offered many helpful suggestions.

References

BATES, M. 1949. The natural history of mosquitoes. New York. The Macmillan Co. 379 pp.

BLAKESLEE, T. E., AXTELL, R., and JOHNSTON, L. 1959. *Aedes vexans* and *Culex salinarius* light trap collections at 5 elevations. Mosq. News 19(4):283.

BURGESS, L. 1957. Note on *Aedes melanimon* Dyar, a mosquito new to Canada (Diptera: Culicidae). Canad. Ent. 89(11):532.

CARPENTER, S. J., and LACASSE, W. J. 1955. Mosquitoes of North America (north of Mexico). Berkeley and Los Angeles: University of California Press. 360 pp.

DEANE, L. M., DAMASCENO, R. G., and AROUCK, R. 1953. Distribuição vertical de mosquitos em uma floresta des arredores de Belém, Pará. Folia clin. biol. 20(2):101–107. São Paulo, 1953.

HADDOW, A. J., GILLETT, J. D., and HIGHTON, R. B. 1947. The mosquitoes of Bwamba County, Uganda. V. The vertical distribution and biting cycle of mosquitoes in rain-forest, with further observations on microclimate. Bul. Ent. Res. 37: 301–330.

HAUFE, W. O., and BURGESS, L. 1960. Design and efficiency of mosquito traps based on visual response to patterns. Canad. Ent. 92(2): 124–140.

HORSFALL, W. R. 1955. Mosquitoes. Their bionomics and relation to disease. New York, The Ronald Press Company. 723 pp.

LOVE, G. J., and SMITH, W. W. 1958. The stratification of mosquitoes. Mosq. News 18(4): 279–283.

MACCREARY, D. 1941. Comparative density of mosquitoes at ground level and at an elevation of approximately one hundred feet. J. Econ. Ent. 34(2):174–179.

MATHESON, R. 1944. Handbook of the mosquitoes of North America. 2nd Ed. Ithaca, New York. Comstock Publishing Company, Inc. 314 pp.

MCLINTOCK, J. 1944. The mosquitoes of the Greater Winnipeg area. Canad. Ent. 76(5):89–104.

REMPEL, J. G. 1953. The mosquitoes of Saskatchewan. Canad. J. Zool. 31:433–509.

SNOW, W. E. 1955. Feeding activities of some blood-sucking Diptera with reference to vertical distribution in bottomland forest. Ann. Ent. Soc. Amer. 48(6):512–521.

SNOW, W. E., and PICKARD, E. 1957. Correlation of vertical and horizontal flight activity of *Mansonia perturbans* with reference to marked changes in light intensity. (Diptera, Culicidae). Ann. Ent. Soc. Amer. 50(3):306–311.

A COMPARISON OF FOUR DIFFERENT ADULT DIETS FOR THE ROUTINE LABORATORY REARING OF *AEDES AEGYPTI* (L.) [1]

J. N. LILES,[2] R. MEOLA, W. L. JONES, AND D. M. DeLONG
The Ohio State University, Columbus 10

Introduction. The method for maintaining egg production in laboratory colonies of the yellow fever mosquito usually consists of making available to the females, at various intervals, some species of live host. While this method is quite successful, the fact remains that expense and time is involved in maintaining stock colonies of the host.

Attempting to avoid use of the live host, Lea *et al.* (1955) and Knierim *et al.* (1955) began investigations of other proteinaceous materials, supplied on gauze covered cotton pads. The first method employed whole citrated beef blood, and later, mixtures of nine parts citrated beef blood and one part honey. Prior to this, MacGregor and Lee (1929) and McLintock (1952) had used the blood soaked pad method. These investigators added either sugar or honey to the citrated blood.

Since 1955, the stock mosquitoes in this laboratory have been maintained quite successfully on a diet of citrated, hemolyzed beef blood, containing 10 percent sucrose. The method is simply to visit a slaughterhouse with one-gallon jugs in which have been placed approximately 250 ml. of 5 percent sodium citrate. Have these jugs filled with beef blood, and later, at the laboratory, add 10 percent sucrose, and place the blood in conveniently sized containers in the deep freeze. The treated blood is then thawed and used as necessary. The addition of sucrose or honey or other sugars is necessary as a phagostimulant if the blood is frozen because freezing ruptures the red corpuscles. Without whole red cells the blood is not fed upon unless it is sweetened.

Subsequently, Lea *et al.*, (1955, 1956) found that the mosquitoes would produce viable eggs if fed on milk-soaked pads, as well as on a variety of other proteinaceous materials such as powdered egg albumen, proteose-peptone, and the enzymatic digests of soybean meal, yeast, casein, and lactalbumen. Dimond *et al.*, (1955, 1956) showed that the mosquito would produce viable eggs on a synthetic diet composed of 12 amino acids, inorganic salts, and sugars.

Some of these diets would be more convenient to use, both for stock colonies as well as for particular investigational problems, provided that adequate viable egg production results, and that the offspring of subsequent generations are adequate egg producers and are normal in other respects such as longevity. Often the question has been asked "just how good are these diets?"

This study concerns the practical laboratory efficiency of three of the most promising non live host diets when compared with the use of a live host.

The four diets tested were: live host (laboratory mouse); citrated, hemolyzed beef blood containing 10 percent sucrose; a liquid mixture of the 12 essential amino acids, inorganic salts, and 10 percent sugars (Dimond *et al.* (1956); and a 10 percent egg albumen (Nutritional Biochemicals Corp.) plus 10 percent sucrose solution.

Items of particular considerations were: (1) number of days beyond the initial meal to the appearance of first eggs; (2) growth rate of the larvae resulting from eggs laid by adults receiving the various diets; (3) total and total viable egg produc-

[1] This investigation was supported by a research grant, E 528 (C-9), from the National Institutes of Health, U. S. Public Health Service.

[2] Present address: Dept. of Zoology and Entomology, The Univ. of Tennessee, Knoxville 16, Tennessee.

tion; and (4) longevity of the adults and longevity and productivity of the offspring of adults fed the different diets.

MATERIALS AND METHODS. Stock eggs less than two months old, stored at 26–27° C. and 50–60 percent relative humidity were hatched. The larvae were fed Gaines Homogenized Dog Meal, and reared according to the method of Burcham *et al.*, (1956). Upon emergence of 90 percent of the pupae, the mosquitoes were inactivated in the cold room, whereupon 50 males and 50 females were placed in each experimental cage (12″ by 8″ by 9″). Two replications were used in each case. Ten percent sucrose solutions were placed in the cages to provide food for the young adults.

Two days after the experimental cages were set up, all received the initial feeding. All continued to be fed every other day until egg production ceased and, in some cases, until all of the insects were dead. All diets, other than the live host, were presented by pouring the solution, warmed to about 50° C., onto a gauze-covered cotton pad, and the pad was then placed in a small aluminum cup in the cage. The mice were placed securely in small screen cages, placed in the cages with the mosquitoes, and left for two hours. All live host feeding was done in the afternoon.

New cups containing oviposition strips were added daily or every other day, aged for four days, counted, and in some instances, hatched.

Representative groups of eggs collected from the first generation were then hatched in definite groups according to the days when the eggs were laid. In other words, eggs were hatched for second generation studies from those laid in (A) the first five days of the egg laying period, (B) from 6–10 days, (C) 11–15 days, and (D) 16–20 days. In addition, viability data were recorded for the rest of the egg-laying period, but not enough viable eggs were present from the two non-blood diets to make up an equivalent test. This method was used in order to determine whether failure of a diet might occur at some point during the egg-laying period. A similar arrangement, but on a somewhat reduced scale, was carried out with the third and fourth generations.

RESULTS AND DISCUSSION. The number of days following the initial meal to appearance of first eggs differed, and this difference remained fairly constant throughout the four generations. The average number of days were: live host, 2.2; hemolyzed blood, 3.5; synthetic, 4.5; and egg albumen, 4.5. These differences were about as expected since sugars must be added to all three non-live host diets as a phagostimulant. Sweetened materials go first to the ventral diverticulum instead of to the midgut, as whole blood does, and are apparently pumped to the midgut as the sugars are utilized. Therefore, it is likely that the necessary proteins would not reach the midgut as rapidly or in as great quantity. Also, some extra time may be necessary for additional syntheses with use of the two non-blood diets. In addition, the time tended to increase about one day in adults reared from eggs laid late (after two weeks) in the egg-laying period of the preceding generation, if the diet was synthetic or egg albumen.

Growth rate of the larvae during all parts of the second, third and fourth generations indicated little change. The overall averages in days for four groups of the second generation, plus an early group of the third and fourth generations were: live host, 10.3; hemolyzed blood, 10.4; synthetic, 10.6; and egg albumen, 10.8. More important, the times did not tend to increase or decrease in the generations subsequent to the first generation.

A marked larval mortality (50–60 percent) was recorded when using eggs laid late in the egg-laying period of the preceding generation with the two non-blood diets. This occurred in eggs laid after three weeks of egg-laying.

Egg productivity varied enormously depending upon the diet. Lea *et al.* (1956) found the same. Therefore, the purpose of this portion of the work was to evaluate (1) viable egg production in 40 days, and

(2) the longevity and productivity of the offspring resulting from eggs laid at various intervals during the egg-laying period of the preceding generation.

The results of one of the tests where complete data were recorded for total and total viable egg production are shown in Fig. 1. Forty days of egg-laying was chosen because egg production was practically completed by that time, with the exception of the live host fed insects. Also, it is uncommon to keep a stock cage operating beyond this point.

For the 40 days the overall percentages of viable eggs from the four diets were as follows: live host, 97.0; hemolyzed blood, 94.5; synthetic, 81.5; and egg albumen, 60.6.

It may be noted from Fig. 1, that the percentages or numbers of viable eggs

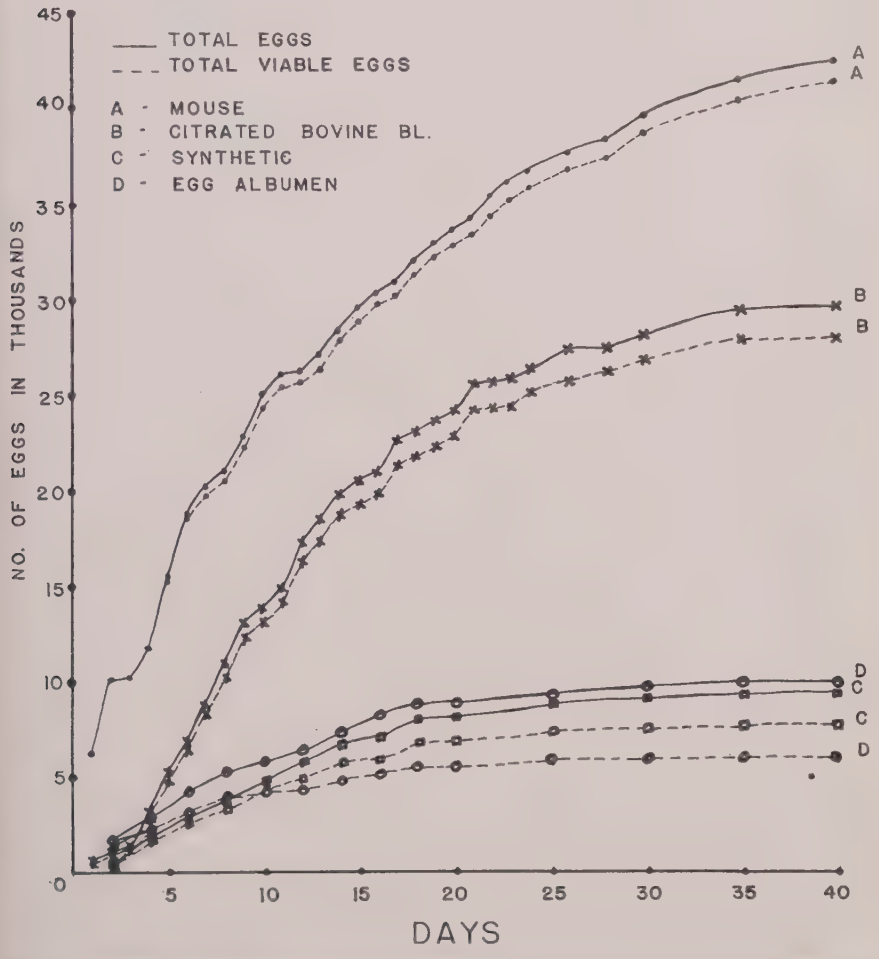


Fig. 1.—Comparison of total and total viable egg production in 40 days using four different adult diets. Results are for 100 females with each diet.

from the insect fed on egg albumen were very low after the first week of egg laying. The same was true of the synthetic diet beyond two weeks of egg deposition. The two blood diets produced a very high percentage of viable eggs throughout the 40 days. In all cases, the eggs were subjected to hatching within a day or two after being aged, so the percentages should be maximum.

The data recorded in Fig. 1 were representative of what occurred relative to egg deposition throughout the four generations. The one important difference, again, was with the synthetic and albumen fed insects. If eggs laid two weeks beyond commencement of the egg laying period were hatched, the resulting adults were only about half as productive as normal, and longevity was reduced by approximately one-third.

Adult female longevity averaged about the same on the three non-live host diets, but about 12 percent greater with the live host diet. This was true through all four generations. The "average days lived" figures for the females whose egg depositions are given in Fig. 1, were 46 days for the live host fed, and about 41 days for the other three groups.

CONCLUSIONS. In the general laboratory rearing of our strain of *Aedes aegypti,* feeding on a live mouse definitely resulted in a greater total deposition of viable eggs than with the other diets tested. In addition, the females lived somewhat longer. With the hemolyzed blood, almost as high percentages of the eggs were viable as with the live host. This was not true of the other diets.

Production of viable eggs was very low beyond two weeks of egg deposition with the synthetic diet and one week with the egg albumen. On the other hand, the numbers of eggs produced in a stock colony are almost always in extreme excess of those utilized. The hemolyzed blood diet has served us extremely well for the past five years. Although the time of larval development and the number of days beyond initial feeding to deposition of first egg was slightly greater using the non live host diets, this would rarely be of consequence.

In all probability all of the diets tested would be applicable for specific investigational purposes. One such use for the hemolyzed blood, in addition to general stock rearing, has been in the feeding of single pairs of mosquitoes in small cages for genetics research. If one is using a number of single pair cages, the use of many live hosts is a disadvantage. In addition, it has been our experience that single females often do not feed well. Using the combined sugar and blood source conveniently insures feeding and egg deposition in virtually all cases.

Finally, we must point out that these conclusions were based on work with the Ohio State strain of mosquitoes. We have used the non live host diets with other strains, but not always with comparable results.

References

BURCHAM, E. G., LEA, A. O., DIMOND, J. B. and DELONG, D. M. 1956. Laboratory rearing procedures for *Aedes aegypti* and *Culex pipiens.* North Central Br. Papers, Wis. Alumni Research Found., Insecticide Testing Lab. Madison, Wis. 7 pp.

DIMOND, J. B., LEA, A. O., HAHNERT, W. F., JR., and DELONG, D. M. 1956. The amino acids required for egg production in *Aedes aegypti.* Canad. Ent. 88(2):58–62.

DIMOND, J. B., LEA, A. O., BROOKS, R. F. and DELONG, D. M. 1955. A preliminary note on some nutritional requirements for reproduction in female *Aedes aegypti.* Ohio Jour. Sci. 55:209–211.

KNIERIM, J. A., LEA, A. O., DIMOND, J. B. and DELONG, D. M. 1955. Feeding adult mosquitoes on preserved blood to maintain egg production. Mosq. News 15(3):176–179.

LEA, A. O., DIMOND, J. B. and DELONG, D. M. 1956. Role of diet in egg development by mosquitoes (*Aedes aegypti*). Science 123(3203): 890–1.

LEA, A. O., KNIERIM, J. A., DIMOND, J. B. and DELONG, D. M. 1955. A preliminary note on egg production from milk-fed mosquitoes. Ohio Jour. Sci. 55(1):21.

MACGREGOR, M. E., and LEE, C. U. 1929. Preliminary note on the artificial feeding of mosquitoes. Trans. R. Soc. Trop. Med. Hyg. 23: 465–472.

MCLINTOCK, J. 1952. Continuous laboratory rearing of *Culiseta inornata* (Will.) (Diptera: Culicidae). Mosq. News 12:195–201.

SURVEY OF LOG POND MOSQUITOES IN DOUGLAS COUNTY, OREGON, DURING 1956

F. C. HARMSTON,[1] L. S. MILLER,[2] AND R. A. McHUGH [1]

During 1956, a survey of log pond mosquitoes in Douglas County, Oregon, was conducted cooperatively by the Oregon State Board of Health, the Douglas County Health Department, and the Communicable Disease Center, U. S. Public Health Service. This paper presents the findings of this survey, which included log ponds and adjacent urban and suburban areas at Roseburg, Sutherlin, Myrtle Creek, Riddle, Drain, and Elkton.

Larval Mosquito Data. Seven log ponds were selected in the spring of 1956 for an ecologic study of mosquito larvae. Seasonal trends in larval populations were determined by taking a minimum of 60 dips in each pond at biweekly intervals. The earliest spring samples (April 15 to 18) showed only a few larvae of *Culiseta incidens, Culex tarsalis,* and *Culex peus* in several ponds. By May 15, most of the ponds contained larvae of these three species in populations averaging less than one larva per dip. Larval populations of the three species remained at a low level until the latter part of June when a significant and steady increase in the numbers of *C. tarsalis* was noted (Figure 1). *C. tarsalis* was the predominant species until about the middle of July when the larval population leveled off and *C. tarsalis* was then exceeded by *C. peus,* which thereafter was the predominant species. Larval populations of *C. incidens* were low during May and June but showed a rapid increase after the middle of July and reached their peak about the middle of August. During the first part of August, a rapid decline was noted in the numbers of *C. tarsalis* in the log ponds; in the case of *C. peus* and *C. incidens,* this decline (in larval populations) occurred during the latter part of August.

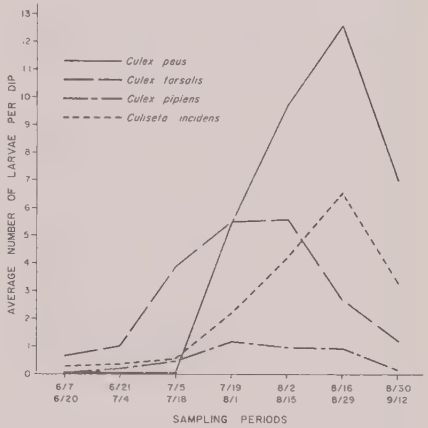

Culex peus
Culex tarsalis
Culex pipiens
Culiseta incidens
AVERAGE NUMBER OF LARVAE PER DIP
SAMPLING PERIODS
6/7 6/20 6/21 7/4 7/5 7/18 7/19 8/1 8/2 8/15 8/16 8/29 8/30 9/12

Fig. 1. Biweekly moving averages of numbers of mosquito larvae obtained by dipping in 7 log ponds in Douglas County, Oregon, 1956.

A few ponds were found to produce substantial numbers of *Culex pipiens,* but the over-all production of this species in log ponds was much lower than that of *C. tarsalis, C. peus,* and *C. incidens.* Production of *C. pipiens* was noted in situations other than log ponds. These situations included a sewage-polluted stream in the vicinity of Sutherlin, and small surface depressions that contained effluent from septic tanks.

In several ponds, large numbers of *Mansonia perturbans* larvae were collected by pulling up clumps of cattails and shaking out the roots in a pan of water or by dipping under floating mats of cattails. Scores of *Mansonia* larvae were found attached to roots in late May and early June, but larvae were much more difficult to obtain later in the season. Observations on the occurrence of *Mansonia* in Douglas County log

[1] Technology Branch, Communicable Disease Center, Public Health Service, U. S. Department of Health, Education, and Welfare, Greeley, Colorado.

[2] General Sanitation Section, Division of Sanitation and Engineering, Oregon State Board of Health, Portland, Oregon.

ponds have been reported previously (Miller and McHugh, 1959).

ADULT MOSQUITO DATA. Adult mosquito populations were sampled by means of light traps and biting collections. At each of the 7 log ponds, a light trap was operated 2 nights per week from June 15 through September 7, except in several instances where a trap operated only one night per week because of mechanical difficulty or power failure. A total of 3,550 female mosquitoes was collected in 85 trap-nights. In one daytime and 8 evening biting collections, 472 female mosquitoes were recovered.

Five species of mosquitoes including *C. tarsalis, C. peus, C. pipiens, C. incidens,* and *M. perturbans* comprised 99 percent of the total female specimens taken in the light traps. Six other species including *Aedes sierrensis, Anopheles freeborni, Anopheles punctipennis, Culex restuans, Culex territans,* and *Culiseta inornata* comprised the remaining one percent.

C. tarsalis ranked first among the light-trap specimens and comprised 33 percent of the total number taken (Figure 2).

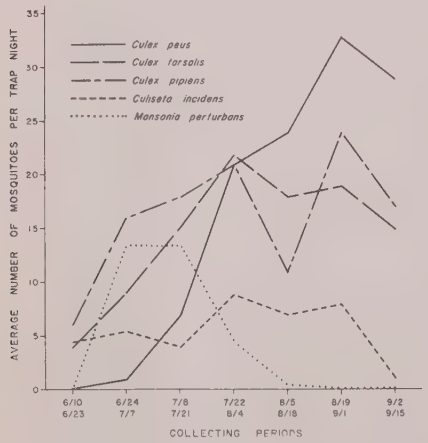


FIG. 2. Biweekly moving averages of adult mosquitoes collected in 8 light traps operated in the vicinity of log ponds in Douglas County, Oregon, during 1956.

The light-trap collections indicated a steady increase in the population of *C. tarsalis* from early June until early August at which time the population density reached its peak. In addition to ranking first in the light-trap collections, *C. tarsalis* comprised 81 percent of the 472 female mosquitoes taken in the evening biting collections.

C. peus was second among the light-trap specimens and comprised 32 percent of the total females collected. This species was not taken in the light traps until the first week in July, despite the fact that small numbers of larvae were present in the log ponds throughout the month of June. Populations of *C. peus* increased very rapidly during the last half of July and reached their peak during mid-August. This was the predominant species in light-trap collections from early August through September 15, when light trap operations were discontinued. Attempts to take *C. peus* in biting collections met with failure, although tremendous numbers of this species were present in the immediate vicinity of the collection sites. It would appear that the production of *C. peus* in log ponds is of little significance from a mosquito control standpoint, since it appears that these mosquitoes rarely feed on man.

C. pipiens ranked third in the light-trap collections and comprised 19 percent of the total females taken. *C. pipiens* comprised a much higher proportion of the light-trap specimens than would be expected from the small numbers of larvae found in the log ponds. Production of this species in habitats other than log ponds, as noted earlier, probably accounted for the relatively large proportion of light-trap specimens. *C. pipiens* was not taken in any of the biting collections even though the light traps showed large numbers of this species to be present at sites where the biting studies were being made.

C. incidens was fourth among light-trap specimens and comprised 11 percent of the total females taken. The collections of *C. incidens* in light traps were consistently low from early June until September. This species comprised 11 percent of the mosquitoes taken in the biting collections.

M. perturbans ranked fifth in the light-

trap collections and comprised 4 percent of the females taken. On the basis of light-trap collections, the population density of *M. perturbans* was highest from the end of June until the middle of July, during which period 119 of the 130 specimens were taken. This species was highly pestiferous in evening biting collections in the vicinity of certain log ponds which contained dense growths of cattails favorable for the development of *Mansonia* larvae.

The treehole mosquito, *A. sierrensis,* was taken in biting collections during the period May 25 to July 12. The largest numbers were taken on May 25, in oak forest habitat near Ridgedale, about 3 miles northwest of Roseburg. In this area, *A. sierrensis* were numerous and highly annoying around sheds, garages, other outbuildings, and porches of several residences. This species was also encountered in considerable numbers in the Sutherlin area. On the basis of observations during 1956, it appears that much of the early-season annoyance attributed to log pond mosquitoes in Douglas County actually is caused by *A. sierrensis.*

Discussion. With regard to the planning of control operations, mosquitoes in the log pond areas of Douglas County may be divided into the following groups: (1) Biting species (*C. tarsalis* and *C. incidens*) for which special control measures may be required in log ponds and conventional control measures in other breeding places. (2) Biting species (*M. perturbans*), which breed in log ponds, but because of their peculiar habit of remaining attached to plant roots, are not subject to conventional control measures, and for which special measures must be developed. (3) Species that rarely bite man (*C. peus* and *C. pipiens*), which breed abundantly in log ponds, but for which control measures may not be necessary. (4) Biting species (*A. sierrensis*), which do not breed in log ponds and must be controlled by species sanitation measures directed at their treehole larval habitats.

Summary. The principal species based on relative abundance of adults over the entire season near 7 log ponds in Douglas County, Oregon, were *Culex tarsalis, C. peus* and *C. pipiens;* the last species was, however, much less abundant in the larval collections. *Culiseta incidens* and *Mansonia perturbans* occurred in much lower numbers than the three species of *Culex.*

Reference Cited

Miller, L. S., and McHugh, R. A. 1959. A note on *Mansonia* breeding in Oregon log ponds. Mosquito News 19(3):198.

VIRGINIA MOSQUITO CONTROL ASSN.

5721 Sellger Drive, Norfolk 2, Virginia

George C. Lyon, Ocean Park, President

Jack E. Dent, Norfolk, First Vice President

Philip P. Davis, So. Norfolk, Second Vice President

C. E. Johnson, Hampton, Third Vice President

R. E. Dorer, Norfolk, Secretary-Treasurer

A NOTE ON THE BIONOMICS OF *AEDES ATROPALPUS* (COQUILLETT) [1]

L. G. STROM,[2] H. A. TREVINO [3] AND E. G. CAMPOS [3]

Aedes atropalpus is a widely-distributed mosquito, recorded from the eastern United States west to New Mexico and from Southern Canada to Central America by Carpenter and La Casse (1955). It has long been characterized as a species breeding primarily in rock holes filled with water from overflowing streams or rainfall. This mosquito attacks man freely and is a persistent biter. However, it has generally been considered to be a minor pest, as a consequence of its specialized larval habitat and relatively short flight range.

There have been recorded exceptions to *Ae. atropalpus* breeding in rock holes. Kumm, *et al.* (1940) collected the species from cemetery urns and vases in Costa Rica. Hedeen (1953) recovered *Ae. atropalpus* from tree holes in Pecos County, Texas, on two occasions and once from an artificial container in association with *Ae. aegypti* in Medina County, Texas. Hedeen (loc. cit.) has shown that *atropalpus* requires no unusual aquatic media or food for normal development under laboratory conditions.

As pointed out by Bates (1954), it is often difficult to demonstrate physiological or structural adaptions which would limit certain mosquito larvae to the highly restricted habitats in which they are found. Many of these larvae from widely diverse ecological situations will develop in a common medium in the laboratory. Thus adult oviposition selectivity would appear chiefly responsible for the sometimes bizarre larval developmental habitats.

Observations concerning the bionomics of this species made by personnel of the Medical Entomology Laboratory, Foreign Quarantine Station, Public Health Service, Brownsville, Texas, are considered of sufficient interest to report. *Ae. atropalpus* larvae and pupae have been collected for 3 consecutive years from discarded airplane tires containing water, during *Ae. aegypti* surveys of the San Antonio, Texas, International Airport and vicinity. *Ae. aegypti* surveillance is maintained at international traffic points in the southern United States by entomologists of the Foreign Quarantine Division, Public Health Service.

Aedes larvae, subsequently shown microscopically to be *atropalpus,* were first recovered from 10 airplane tires at the San Antonio Airport Aug. 14, 1958, in association with *Culex quinquefasciatus* larvae. The large tires held from 5 to 10 gallons of water and both *Aedes* and *Culex* larvae were present in large numbers. A second trip was made to the San Antonio Airport Oct. 15, 1958, and 35 tires were discovered holding water, all of which contained large numbers of *Ae. atropalpus* and *C. quinquefasciatus* larvae.

Numerous premises were inspected in San Antonio in cooperation with Mr. C. R. Mason, Sanitarian, City Health Department, but it was not until May 12, 1959, that *Ae. atropalpus* was found in a second location, an aircraft tire company, some 15 miles south of the Airport. This mosquito was taken in numbers from used aircraft tires, in association with one or more of the following species: *Ae. aegypti, A. crucians,* and *C. quinquefasciatus.* One tire contained all 4 species.

Ae. atropalpus has been collected from used aircraft tires in San Antonio, Texas, from the 2 original locations on 8 different occasions: Aug. 14, 1958; Oct. 15, 1958; March 11, 1959; May 11, 1959; May 12, 1959; Aug. 17, 1959; Aug. 19, 1959 and Aug. 2, 1960. Breeding was extensive,

[1] A contribution from the Medical Entomology Laboratory, Quarantine Station, Public Health Service, U. S. Department of Health, Education and Welfare, Brownsville, Texas.

[2] Deceased; formerly Station Entomologist.

[3] Biologists, Entomology Program.

with larvae frequently being found in 10 or more tires. Adult annoyance was encountered only once. May 12, 1959, *Ae. atropalpus* and *Ae. aegypti* were attacking in numbers at 6:00 p.m., when one of the sites from which *atropalpus* larvae were recovered was visited.

The collection of *Ae. atropalpus* from water-filled aircraft tires gives further indication that microscopic appraisal should be given all mosquitoes collected during *Ae. aegypti* surveys. Still another *Aedes,* the tree-hole-breeding *triseriatus,* has been commonly taken from tin cans and other artificial containers in San Antonio and elsewhere in Texas (Texas State Department of Health unpublished records). Personnel conducting *Ae. aegypti* surveys should be thoroughly cognizant of the fact that *Aedes* other than *aegypti* are not infrequently found in artificial containers. This should be especially stressed when temporary summer employees are utilized in *Ae. aegypti* surveys.

This demonstration of urban breeding of *Ae. atropalpus* in artificial containers indicates that its disease transmission potential is much greater than formerly believed. A species limited to rock holes in rural areas for larval development, and with a limited flight range, would be of little concern as a primary vector. Its presence in water-filled tires is additional justification for the elimination of these larval developmental sites in mosquito control programs.

Summary

Ae. atropalpus, a species commonly utilizing rock holes of temporary water for larval development, has been discovered in San Antonio, Texas, in water-filled, used, aircraft tires. Eight findings over a 3-year period have shown extensive adaption to this habitat.

References

Bates, M. 1954. The natural history of mosquitoes. The Macmillan Co., New York, N. Y. 375 pp.

Carpenter, S. J., and La Casse, W. J. 1955. Mosquitoes of North America. Univ. of California Press, Berkeley, Calif. 360 pp.

Hedeen, R. A. 1953. The biology of the mosquito *Aedes atropalpus* Coquillett. Jour. Kans. Ent. Soc. 26(1):1–10.

Horsfall, W. R. 1955. Mosquitoes. Ronald Press Co., New York, N. Y. 723 pp.

Kumm, H. W., Komp, W. H. W., and Ruiz, H. 1940. Am. Jour. Trop. Med. 20:385–422.

THE MOSQUITO FAUNA OF KOHAT-HANGU VALLEY, WEST PAKISTAN

M. QUTUBUDDIN [1]

Description of the Area. The Kohat-Hangu valley is situated in Kohat District of the Province of West Pakistan (33.34 N, 71.27 W). The altitude varies from 3,000 to 4,000 feet above sea level. Parallel to the 26-mile long road between Kohat and Hangu, which passes through the hill tract, is the river which gains in its volume by confluence of hill streams at frequent intervals. The river bed, which is mostly rocky and covered with gravel, is, for the most part, devoid of any vegetation excepting a few patches of grass around the rocky pools which give protection to anopheline larvae. The soil is alluvial. Most of the villages are situated on either side of the river and quite a few are on the hillocks. Excepting areas where there is water supply by hill streams most of the tract is stony waste covered with a few stunted shrubs. Natural vegetation other-

[1] At present Medical Entomologist, Ministry of Health, Sudan Government.

wise is sparse, excepting the orchards watered by streams.

KOHAT CANTONMENT. The cantonment is well wooded, and apart from the gardens of the bungalows, it is largely under cultivation. Most of the country in the immediate neighbourhood of the cantonment is also cultivated, growing mainly vegetables and grain, e.g. wheat and barley. There are no rice-fields in close proximity to the cantonment. There are a large number of water channels in the area which irrigate the fields and also water the gardens. These channels during the course of flow become untidy, and thus provide pools and puddles in which breed anopheline mosquitoes.

CLIMATE AND METEOROLOGY. According to the climate classification of West Pakistan proposed by Ahmad (1951), the valley lies in the Secondary Division, Kohat-Waziristan of the minor region of Middle Himalayas and northwestern hills under the major region, the subtropical continental highlands. The winters are cold and snowy, with winter showers. The second rainy season in the area is the spring season. The climate is dry and hot in summer and cold and humid in winter. The maximum temperature reached in May and June is 107° F.–108° F. and the minimum in December and January is 47° F. Kohat, which is at one end of the valley, registers an annual rainfall of 10 inches, and Hangu which is at the other, receives a precipitation of 16–26 inches annually. Thus the mean for the valley is about 18 inches. Naqvi and Qutubuddin (1954) have given tables showing rainfall and humidity figures for the year 1948, and 1949. From these figures it appears that February and March, on the one hand, and July and August on the other, account for the highest rainfall. These are also the months of highest humidity.

BREEDING SITES OF ANOPHELINES. Sinton (1917), who made a survey in the area and reported on the malaria figures and anopheline mosquitoes of Kohat district, restricted his investigations mostly to the cantonment. Hence a detailed account of the various breeding places of anopheline and culicine mosquitoes in the valley is lacking. Naqvi and Qutubuddin (1954) confined themselves to a detailed description of breeding sites of anopheline species only, which is briefly recapitulated below with a view to presenting here a complete picture of ecological conditions in the valley.

Drain pits, formed from the irrigation channels that take off from the hill streams; borrow pits made at the time of the construction of the railway; and ricefields, which are few, are the breeding sites of *A. culicifacies* the malaria vector, and *A. fluviatilis* a probable factor in malaria transmission.

BACK WATER FROM HILL STREAMS. These are small and large collections from hill streams in the river bed in which breed *A. culicifacies* Giles, *A. maculatus* Theobald and *A. turkhudi* Liston.

SLOW RUNNING WATER AND ROCKY PITS. In the river bed there are slow running water courses and rocky pits devoid of vegetation. These are also breeding sites of *A. culicifacies* and five other species.

FOOTHILL STREAMS. The fast running hill streams breed *A. fluviatilis* James.

IRRIGATION CHANNELS. Are the branches of the hill streams.

TANKS. Water for drinking purposes is stored in masonry and mud tanks. These receptacles are not the major source of anopheline breeding but neither are they completely free from it.

Of the above, borrow pits and drain pits are described as the most frequent breeding sites of the vector, *A. culicifacies*.

BREEDING SITES OF CULICINES. The principal breeding sites of the 22 culicine species reported here were as follows:

THE CHILLI BAGH AREA. Midway between the two towns Kohat and Hangu is a vast, thickly wooded area, overgrown with wild vegetation which is the chief source of culicine mosquitoes. There are trees there which hold rain water and provide breeding places for the tree-hole breeders. From this area about 75 percent of culicine mosquitoes reported below were collected.

Masonry Wells. Unused rotting masonry wells, although not very numerous in the valley, are a source of culicine breeding. There are undoubtedly other breeding places of culicine mosquitoes in the area, but no special efforts were made to locate them.

Mosquito Fauna. Sinton (1917) did not present a detailed account of the mosquito fauna. Naqvi and Qutubuddin (1954) reported the following species of *Anopheles: culicifacies* Giles, *stephensi* Liston, *fluviatilis* James, *maculatus* Theobald, *annularis* Wulp, *superpictus* Grassi, *turkhudi* Liston, *splendidus* Koidzumi, *lindesayi* Giles, *d'thali* Patton, *pulcherrimus* Theobald, *subpictus* Grassi, *hyrcanus* (Pallas).

Of these 13 species of *Anopheles,* they could locate the breeding places of only 9. Intensive and extensive search for those of *A. superpictus, A. splendidus, A. d'thali* and *A. lindesayi* proved futile.

No adults, but only the larvae, of *A. hyrcanus* were taken in the valley. *A. subpictus* was the species found in the largest numbers, *A. pulcherrimus* in the fewest number, during the period of its survey from August to December.

Culicine Mosquitoes. There is no previous record of the culicine mosquitoes of the valley. As far as could be ascertained Barraud (1934) did not report any culicine species from the area. He mentioned some species occurring in the former N.W.F. Province but none from this valley. The present personal collection was casually made by the author out of interest aroused in the culicine fauna because some species which were vicious biters proved a serious nuisance during the course of collecting of *Anopheles* in certain areas, particularly the woods near Chilli Bagh. Several culicine species landed, by the hundred, on collectors in the area and bit so viciously in the day time, that collections could be made by one man from another while these mosquitoes sucked blood. Among these, as will be seen below, were mostly members of the subgenus *Stegomyia* and some of the genus *Culex*. The culicine fauna of the valley appears to be very rich and it is likely that a special survey made round the year may yield a much larger number of species.

In a collection of moderate size made from August to December, 22 species of Culicines belonging to 4 genera and 9 subgenera were identified; a detailed account of them is given below. This number is definitely far short of the total number of species that exist in the area.

1. *Culiseta indica* (Edwards). Several examples of this species were bred from larvae collected in November from foul-smelling water in an unused masonry well at Kachai village. There were many more females than males among the adults reared in this way. The occurrence of larvae in foul water is rather unusual for the genus in the Indian subregion. The other two species known from the subregion breed in ground pools and sometimes in beds of hill streams. Palpi in female adults were found to be very variable being from 1/7 to 1/5 of the proboscis in length.

2. *Aedes (Stegomyia) aegypti* (Linnaeus). Not a common species in the valley; it was collected on a few occasions biting in day time in the woody area of Chilli Bagh. It is greatly outnumbered by *w-albus* (Theobald) and its rival *albopictus* (Skuse). Since I am not at present in possession of the specimens collected in the area it is not possible to say which of the three forms recognized by Mattingly (1957) occurred in the valley. But since *Aedes aegypti* var. *queenslandensis* Theobald is common in the Mediterranean area, and Barraud (1934), not specifying particular localities, mentions it as occurring in India; and also because Mattingly thinks that *Aedes aegypti* along with a number of other mosquitoes represents a Mediterranean element in northern India and Burma, it is quite reasonable to believe that this pale form may also occur in the area. A detailed investigation in this area and for that matter in the whole of W. Pakistan will be needed in order to ascertain the occurrence of the forms of *aegypti* and limits of their penetration inland.

3. *Aedes (Stegomyia) w-albus* (Theo-

bald). A very common species in the valley; found throughout the season from August to December. It was always taken biting in day time in the Chilli Bagh area.

The marking of the thorax shows great variation; all the patterns shown by Barraud (1934) in Pl.VI Figs. 6–8 were observed. The white spot on the mid femur is also variable in position as well as in magnitude; on some it is smaller and more distal than in others. Genotypic significance, if any, of this variation is not known.

4. *Aedes (Stegomyia) albopictus* (Skuse). This species, also caught biting in Chilli Bagh, occurs in larger numbers than *aegypti* and almost equal in numbers to *w-albus*. The occurrence of this species in the valley, with a mean annual precipitation of 18 inches is of interest since over most of its range it is associated with a very heavy rainfall.

5. *Aedes (Stegomyia) unilineatus* (Theobald). Caught in moderate numbers from the same area as the above species.

6. *Aedes (Stegomyia) vittatus* (Bigot). A few specimens of this species also were taken in the same area while they were biting in day time.

7. *Aedes (Aedimorphus) pipersalatus* (Giles). Bred from larvae collected in a rotting masonry well in the month of September; not very frequently encountered in the area. A few points about the male terminalia are worth mentioning here. Coxite densely covered with strong bristles. No basal lobe present. Phallosome well-developed, lateral plate with four finger-shaped highly sclerotised teeth.

8. *Aedes (Aedimorphus) pallidostriatus* (Theobald). Many males and females bred from larvae collected in September. Male terminalia: Pubescent area of style under the curved ventral spine with a brush of long, fine hairs.

9. *Aedes (Diceromyia) micropterus* (Giles). A few females; not very common. The subgenus appears to be represented by the single species in the area. From the distribution given by Barraud, Punjab, where this species is found, is the western limit of the subgenus in the subcontinent. The other four species occur east of a line drawn from Delhi to Bombay. The occurrence of this mosquito in the area only suggests that it is a most widely distributed species from Kohat in the northwest to Madras in the southeast, and as far east as Bihar.

10. *Aedes (Aedes) indicus* (Theobald). The subgenus is represented by the single species in the area, a single female of which was taken.

11. *Armigeres (Armigeres) subalbatus* (Coquillett). A very common species in the valley; females caught outnumber the males. The abdominal markings are very constant. It may be mentioned here that the curving inwards of spines of the *bl* of coxite in the case of *kuchingensis* Edwards, as against outwards in *subalbatus* mentioned by Barraud, appears to be the result of flattening, as sometimes both conditions are observed in the two basal lobes of the same terminalia. On many occasions this species was collected on man.

12. *Culex (Lutzia) fuscanus* Wiedemann. Several males and females of this species were taken during the survey.

13. C. *(L). raptor* Edwards. This species is equally common in the area.

14. *C. (Lophoceratomyia) minutissimus* Theobald. It is not a very common species but a few examples were caught in the valley.

15. *C. (Culex) bitaeniorhynchus* Giles. Several males and females of this species were taken in the area while biting man. The two varietal forms *ambiguus* and *tenax* do not seem to occur here. The median pale band on the proboscis is very variable in size, particularly in the female. In some specimens it was twice as broad as in others. Speckling of pale scales between the pale band and the base was observed in most specimens.

16. *C. (C). vishnui* Theobald. A few specimens of this species were collected on man during the survey; identified by the dissection of male genitalia since its very close ally *C. barraudi* Edwards also occurs in the area.

17. *C. (C). barraudi* Edwards. This species, which occurs in small numbers

here, was also identified by the dissection of male terminalia. In some specimens the mesonotal scales were observed to be exceptionally pale as in *gelidus* Theobald or *whitmorei* (Giles).

18. *C. (C). tritaeniorhynchus* Giles. Occurs in small numbers in the valley. Lateral plate of phallosome was typical of the species but pubescence on the external plate was more dense.

19. *C. (C). mimeticus* Noe. A few males and females were taken.

20. *C. (C). theileri* Theobald. It was bred from larvae collected in association with *Culiseta indica*. Certain morphological details are worth mentioning. Scaling of pleurae as described by Barraud viz., a large patch on upper portion of mesepimeron. Proboscis brown but no median distinct pale area beneath. CV4–5, distinctly nearer base of wing than CV–4. Tergite II answers to Edwards (1941) description, viz., without a transverse band, but with a median longitudinal area of white scales which extends the whole length touching the border. In some, tergite III also somewhat like II, with no complete basal band, but a longitudinal line extending forwards.

21. *C. (C). univittatus* Theobald. This is not a very common species in the area, but a small number of specimens were collected. The spine of the ventral lobe of the phallosome is very similar to those figured by Mattingly (1954) from *Zaria* and *Djanet* in Africa.

22. *C. (C). pipiens fatigans* Wiedemann. A common species in the valley. It was collected biting man. The terminalia of several specimens examined closely resemble those of *C. p. fatigans* in the shape of the external process of phallosome. The palpi in two specimens from Kohat are somewhat like those of *australicus* Dobrotworsky and Drummond. The proboscis in one specimen is quite long. The ratio of the length of the upper fork cell to its petiole in the female wing varied from 3 to 4.5, the mean being 3.6. Number of hairs on the shaft of the male palp in specimens with a long proboscis is about 10. In another specimen with upturned palpi and normal proboscis, it is 16.

Relationship to Disease and Other Relevant Facts. Dissection of guts and glands showed *A. culicifacies* to be the vector of malaria in the valley. The sporozoite rate was 0.26 percent in August; 1.43 percent in September and 0.27 percent in October and 0 percent in November. Since *A. culicifacies* is one of the chief vectors of rural and suburban malaria in the Indo-Pakistan sub-continent, a great deal of work has been published on it, including an exhaustive review by Afridi and Puri (1940) and another by Rajindar Pal (1945). Subsequently the mosquito has been the subject of extensive and intensive investigations in South India by Russell and his co-workers. Most of this work has been referred to and summarized by Thomson (1951).

Since the present investigation lasted only from August to December the seasonal incidence of *A. culicifacies* could not be thoroughly studied. Nevertheless, it was observed that the species maintained a uniform density throughout the period of survey. Richmond and Mendis (1930) reported from Peshawar, about 40 miles from Kohat, that adult *culicifacies* were not encountered till the end of July, after which the species increased in number till November, the maximum prevalence being from mid-August to mid-November. This appears to be in conformity with our findings as mentioned above. As regards its preferential feeding habits it may be mentioned that a small number of precipitin tests were 65 percent positive for human blood, although most of these specimens were taken from mosquitoes resting in cattle-sheds.

Of the culicine species found in the valley the following have been found biting man: *C. pipiens fatigans, C. bitaeniorhynchus, C. vishnui, Aedes albopictus, Aedes vittatus, Aedes w-albus, Armigeres subalbatus.*

Among these, *C. p. fatigans* is the classical vector of bancroftian filariasis. The possibility of this disease establishing itself in the area, and for that matter, in

the whole of West Pakistan, can not be altogether ruled out, because it is likely that a certain proportion of refugees from Bihar and southern India may harbour the *microfilariae* of *W. bancrofti* in their blood and may serve as carriers of the disease. Further, in another member of the same complex viz., *C. p. molestus* Forskal the natural occurrence and experimental transmission of the West Nile virus has been demonstrated in Israel (See Tahori *et al.,* 1955). *C. univittatus* which is found in the valley in human habitations, is a well-known human biter and a vector of West Nile virus in Egypt, (see Taylor *et al.,* 1956). A virus belonging to the West Nile and Japanese B complex was isolated in southern India from *C. vishnui* and from *C. bitaeniorhynchus* in the Western Ghats. Also, Sindbis virus was recovered from *C. vishnui* and from a mixed pool of *Culex* spp. in Bombay state. It is suggested that this species may play an important role in the transmission of neurotropic viruses in India. Thus, it is evident that a number of dangerous species occur in the valley.

ZOOGEOGRAPHY. According to Wallace the eastern frontiers of Afghanistan and Baluchistan are the boundary of the Oriental Region. Kohat-Hangu valley is almost on this line. Hence, on the one hand it is at the meeting place of the Palaearctic and Oriental Regions, and on the other it is under the influence of the Ethiopian Region through Arabia and of this area, western Saudi Arabia, the Yemen and the eastern and western Aden protectorates are treated by Mattingly and Knight (1956) as Ethiopian, and the remaining divisions of the peninsula as Palaearctic. Now let us see as to what proportion of the total of 35 species occurring in the valley belongs to each of the three zoogeographical regions.

Considering first the anophelines: *A. culicifacies, A. fluviatilis, A. stephensi, A. subpictus, A. annularis, A. maculatus, A. splendidus* and *A. pulcherrimus* all are Oriental species. The Palaearctic element is represented by *A. hyrcanus, A. superpictus, A. d'thali,* and *A. lindesayi. A. turkhudi* according to Mattingly and Knight (1956) is a borderline case between Palaearctic and the Oriental Regions. However, I do not agree with them that it is restricted to western India since I collected it from Aurangabad (India) which is farther south (unpublished record).

Of the 22 species of culicines occurring in the valley *Aedes aegypti* and *Culex pipiens fatigans* are cosmo-tropical, the former occurring in the Ethiopian, Oriental and the Neotropical Regions although its natural range is considered by Mattingly and Knight (1956) to be the Ethiopian and Palaearctic Regions, and the latter is found in the tropics and sub-tropics of the New and the Old Worlds with its natural range possibly in the Oriental Region. Although the origin of *Aedes aegypti* is not known for certain, Mattingly (1953) considers it to be 'a possibly non-ethiopian species.' Of the remaining four *Stegomyia, Aedes w-albus* is an Oriental species. *Aedes albopictus,* besides occurring in the Oriental Region also occurs in South Georgia Archipelago, N.E. China to Manchurian border and Japan, Formosa, Dutch New Guinea and Hawaiian Islands. *Aedes unilineatus* is considered by Mattingly (1952) as a species of interest since it is one of the few Ethiopian *Stegomyia* which also occurs in the Oriental Region. *Aedes vittatus,* probably an invader from the Palaearctic Region, has separate Oriental, Ethiopian and Palaearctic populations and does not primarily belong to any one of these regions. Hence it is regarded as a borderline case by Mattingly and Knight (1956). The three species of *Culex,* viz., *C. tritaeniorhynchus, C. theileri* and *C. univittatus,* each have Oriental, Palaearctic and Ethiopian distribution; the first, which is an Oriental species, occurs as far southwest as Celebes, from the Mediterranean to China, Japan, West Africa and Egypt. *C. theileri* which occurs in the Oriental Regions and in the Mediterranean subregion of the Palaearctic, from Mesopotamia and Persia to Atlantic Islands, and in

the Ethiopian Region in East and South Africa, is regarded by Mattingly and Knight either as a Palaearctic intruder which has spread southwards or as a south African species spreading northwards along the East African Highlands. *C. univittatus* is more widely distributed outside the Oriental Region than within it. It is not regarded as Oriental. Amongst the remaining species, *Culiseta indica* is more or less endemic to the northwestern part of the Indian sub-region. All four species of the genus *Aedes* and *Armigeres subalbatus* and *Culex (Lutzia) fuscanus, C. raptor, C. minutissimus* and *C. barraudi* are purely Oriental species. *C. bitaeniorhynchus* has a wide range of distribution viz., Japan, Australia and the Ethiopian Region. *C. vishnui,* which is common in the Indian subregion, occurs from Mesopotamia to China and Japan. *C. mimeticus,* besides the Oriental Region, also occurs from the Mediterranean subregion to China and Formosa. Thus it would appear that the fauna in the valley is more influenced by the non-Oriental element, whether it be purely Palaearctic or a mixture of such species that are equally prevalent in both regions or are borderline cases.

ACKNOWLEDGMENTS

I am very much indebted to Dr. D. L. Collins for reading through the original MS and making very useful suggestions.

References

1. AFRIDI, M. K. and PURI, I. M. 1940. Studies on the behaviour of adult *Anopheles culicifacies* Part I. Jour. Mal. Inst. India 3(1):1–18.

2. AHMAD, K. S. 1951. Climatic Regions of West Pakistan, Presidential Address, Section of Geography, Geology and Anthropology Third Pak. Sc. Conference, Dacca.

3. BARRAUD, P. J. 1934. Fauna of British India. Culicidae: Tribes Megarhinini, Culicini, London: Taylor and Francis.

4. DOBROTWORSKY, N. V., DRUMMOND, F. H. 1953. Proc. Linnean Soc. New South Wales, Vol. 78, Parts 3–4, pp. 131–146.

5. EDWARDS, F. W. 1932. *Genera Insectorum,* 194. Culicidae, Brussels.

6. EDWARDS, F. W. 1941. Mosquitoes of the Ethiopian Region III, Culicine adults and pupae, Brit. Mus. Nat. Hist., London, England.

7. MATTINGLY, P. F. 1952. The subgenus *Stegomyia* (Diptera:Culicidae), in the Ethiopian Region, Part I. Bull. Brit. Mus. (Nat. Hist.) Entom. 2(5):235–304.

8. ———. 1953. The subgenus *Stegomyia* (Diptera:Culicidae) in the Ethiopian Region, Part II. Bull. Brit. Mus. (Nat. Hist.) Entom. 3:(1).

9. ———. 1954. The distribution of some African mosquitoes. Proc. Linnaean Soc. of London Session 165, 1952–1953, Pt. 1:49–61.

10. ———. 1957. Genetical Aspects of the *Aedes aegypti* Problem; I, Taxonomy and Bionomics, Ann. Trop. Med. Parasit. 51(4):392–408.

11. ———. 1958. Genetical Aspects of the *Aedes aegypti* Problem; II, Disease relationship, Genetics and control, Ann. trop. Med. and Parasit. 52(1):5–17.

12. ——— and KNIGHT, K. L. 1956. The mosquitoes of Arabia, I; Brit. Mus. (Nat. Hist.) 4(3):6–141.

13. NAQVI, S. H., and QUTUBUDDIN, M. 1954. Report on the Malaria Survey of Kohat-Hangu Valley Pak. J. of Health, 3(4):241–253.

14. RAJINDAR, PAL. 1945. Jour. Mal. Inst. India 6:217.

15. SINTON, J. A. 1917. Ind. Jour. Med. Res. 5:195–209.

16. TAHORI, A. S., STERK, V. V. and GOLDBLUM, N. 1955. Studies on the dynamics of experimental transmission of West Nile virus by *C. p. molestus* Amer. J. trop. Med. Hyg. 4(6): 1015–1027.

17. TAYLOR, R. M., WORK, T. H., HURLBUT, H. S., and RIZK, F. 1956. A study of the Ecology of West Nile virus in Egypt. Amer. J. trop. Med. Hyg. 5(4):579–620.

18. THOMSON, R. C. M. 1951. Mosquito behaviour in relation to malaria transmission and control in the tropics. Edwards Arnold and Co., London.

EFFECTIVENESS OF GRANULAR INSECTICIDES AGAINST EYE GNATS AND MOSQUITOES AS AFFECTED BY TOXICANT CONCENTRATION [1, 2]

MIR S. MULLA [3]

University of California Citrus Experiment Station, Riverside

INTRODUCTION. Granular formulations of insecticides can be applied easily to mosquito and eye gnat breeding sites where a thick plant canopy covers the breeding grounds, and they can also be used under conditions where spray applications are ineffective. The superiority of granular insecticides over sprays in penetrating among rice plants to reach water underneath was pointed out by Whitehead (1951). LaBrecque *et al.* (1956) determined the effectiveness of a large number of impregnated granular insecticides against mosquito larvae in the laboratory and in the field. These studies were aimed at finding a more efficient granular formulation for mosquito control. Weidhaas (1957) studied the release of impregnated formulations of organophosphorus insecticides in the laboratory. Lower releases of parathion and chlorothion into water were obtained from the 10 percent granular formulations than from the 1 percent formulations, using attapulgite, vermiculite, diatomite, and pyrophyllite granules. On montmorillonite, the releases from the 10 percent and 1 percent formulations were essentially the same.

In a study of the basic factors influencing the efficiency of impregnated granular parathion in mosquito control, Mulla and Axelrod (1960) determined that solvents used for the impregnation of the granules have a profound effect on the release of parathion into water. Rate of application of a granular formulation, toxicant concentration in the formulation, and size of granules are also factors influencing and regulating the release of toxicants from granules (Mulla, 1960b).

The incorporation of granular DDT into the soil for the control of *Hippelates* eye gnats has been hopefully considered within the past few years, since granular DDT is cheaper and easier to apply to eye gnat breeding grounds than the sprays. However, no investigation has been made of the basic factors contributing to the behavior of granular DDT when applied to the soil; consequently, the efficiency of DDT granular formulations which can be employed economically for eye gnat control is not known.

The effectiveness against *H. collusor* of various concentrations of DDT on attapulgite granules applied to soil at the rate of 20 pounds actual toxicant per acre was studied in the laboratory (Mulla, 1960a). As the concentration of DDT in the formulation increased, the initial effectiveness decreased. Three months after storage the 10 percent formulation was as effective as sprays but the 20 percent and 35 percent formulations were inferior to the 10 percent formulation and the spray treatment. Similarly, in field trials, 10, 20, and 35 percent DDT-impregnated attapulgite granules yielded poorer control of *H. collusor* and *H. hermsi* than DDT sprays (Mulla 1961). Again the effectiveness of the formulations generally decreased as the DDT concentration increased.

The effect of concentration of parathion in impregnated and coated granules on its release into water has been dealt with during the course of this study. Also, tests on the relationship of rate of applica-

[1] Paper No. 1235, University of California Citrus Experiment Station, Riverside, California.

[2] These studies were partially supported by the Coachella Valley, Fresno, Kern, and Westside Mosquito Abatement Districts in California.

[3] The assistance of Harold Axelrod and Harry W. Cramer, Jr., during the course of this work is duly acknowledged.

tion of parathion to water and its release have been carried out. The effectiveness of 10 and 20 percent coated DDT granules against *H. collusor* as soil treatments has been studied and compared with the effectiveness of spray treatment.

Methods and Materials. The impregnated granular formulations of parathion were prepared in the laboratory as described by Mulla and Axelrod (1960). Attapulgite granules (Floridin Company, Tallahassee, Florida) were impregnated with parathion solutions using Chevron Light Solvent (Standard Oil Company of California) and AR-60 (Velsicol Corporation, Chicago, Illinois) as solvents. The solvents comprised about 10 percent by weight of the finished product.

The coated parathion and DDT granular formulations were furnished by Niagara Chemical Division, Food Machinery & Chemical Corporation, Richmond, California. (Wettable powders of the toxicants were coated onto sand cores by means of a water-soluble glue.) The coated parathion and DDT granules were considered to conform to 20/28 mesh size.

For evaluating the release of the toxicant into water from the impregnated and coated parathion granules, desired quantities of the formulations were dropped into a mayonnaise jar containing 3500 ml. of tap water (8.25 inches high) having a pH of 8 to 8.25. The water was kept at a constant temperature of 85° F. The impregnated formulations were added at rates to yield a theoretical concentration of 1 p.p.m. of parathion in the water. In one test where the effect of rate of application on the release was studied, the theoretical concentrations were maintained at 0.5, 1.0, 2.0, and 5.0 p.p.m.

At intervals of 8, 24, 48 and 72 hours, aliquots of the treated water were aspirated from the top and bottom portions of the jar and composited for further dilutions. Small amounts of the composite samples were added to 100 ml. of water in 6-ounce paper cups to obtain final theoretical concentrations of 0.01 to 0.04 p.p.m. The 0.01 p.p.m. theoretical concentration in the cups corresponded to 95 to 98 percent larval mortality. Prior to the addition of the toxicant, 25 fourth-stage mosquito larvae (*Culex quinquefasciatus* Say) were added to each cup. These larvae were kept in the cups at a temperature of 75°–78° F. and the mortality was recorded 24 hours after exposure of the larvae. Each cup was replicated 3 times. The extent of release of parathion was calculated by reading off the amount of parathion corresponding to the mortality, from a standard dosage mortality line of this material against mosquito larvae.

Eye gnat bio-assay tests for evaluating the coated DDT granules were carried on in the laboratory in the same manner as described earlier (Mulla 1960a). The DDT granular formulations and the sprays were each applied to three 1-gallon quantities of soil. One set of treatments was evaluated immediately. The other two sets were stored for one- and three-month periods at 88° ± 2° F. and were tested at this same temperature. Prior to storage, 800 ml. of water were added to each gallon of soil to keep it moist. Prior to testing, the soil was air-dried, mixed with organic matter, and processed for eye gnat bio-assay. Each soil quantity was divided into 10 portions, each of which was placed in a pint jar. Thus each treatment was replicated 10 times. The soil in each pint jar was seeded with 200 eggs of *H. collusor* and the eye gnat emergence was recorded.

Results and Discussion. *Release and Concentration Relationship of Parathion.* —In order to investigate the effect of parathion concentration on its release from the granular formulations, three tests were conducted. In the first test, 1, 2, 5, and 10 percent impregnated granular formulations of parathion were prepared on 30/60 AA-LVM attapulgite granules, using Velsicol AR-60 and Chevron Light Solvent for impregnation. The formulations prepared with AR-60 solvent were aged for two weeks and evaluated at 0.02 p.p.m. in the cups; those prepared with Chevron Light Solvent were two days old and were evaluated at 0.0125 p.p.m. in the cups.

The release-concentration relationship of parathion is not a simple one. Different solvents, carriers, grades of carriers, and other factors are believed to influence this relationship. To determine the influence of solvents on the behavior of various concentrations of parathion in granules, two solvents, one a low volatile (AR-60) and the other a highly volatile solvent (Chevron Light Solvent) were selected. For the AR-60 formulations, a direct relationship between the concentration and the release of parathion was observed (Fig. 1). The 5 percent formulation was markedly lower than that from the 1 and 2 percent formulations. The release from the 10 percent formulation was markedly lower than the releases obtained from the other formulations prepared with Chevron Light Solvent.

In mosquito control, practical concentrations of parathion in granular formulations are considered to be either 1 or 2 percent. Formulations containing higher concentrations are liable to result in incomplete coverage and poor distribution of the gran-

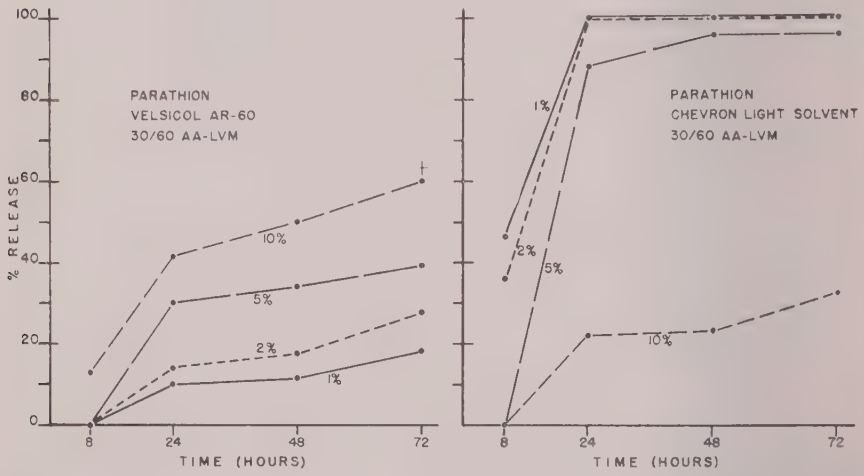


FIG. 1.—Release of parathion into water as related to its concentration in impregnated granular formulations. Attapulgite granules were impregnated with parathion solutions using two solvents. The AR-60 formulations were tested at 0.02 p.p.m. and the Chevron Light Solvent formulations were tested at 0.0125 p.p.m. in the cups.

magnitude of release was the greatest for the 10 percent formulation and the lowest for the 1 percent formulation.

Formulations prepared with Chevron Light Solvent indicated an inverse relationship between the concentration and the release of parathion (see Fig. 1). Increasing the concentration of parathion in the formulation resulted in decreased release of the toxicant into the water. The overall patterns of release from the 1, 2, and 5 percent formulations were similar except at the 8-hour interval. At the 8-hour interval the release of parathion from the ules. Lower concentrations, though desirable for good coverage and uniform distribution of the particles, are expensive to use.

Size of granular particles was found to influence the release of parathion from 0.5 and 1 percent granular formulations (Fig. 2). The 0.5 and 1 percent formulations prepared with Chevron Light Solvent on 30/60 A-LVM attapulgite granules gave essentially the same release of parathion. However, the same concentrations prepared on coarser grades of attapulgite granules (20/40 and 16/30 meshes) yielded

different results. Releases from the 0.5 percent formulations on both the 20/40 and 16/30 meshes were greater than releases from the 1 percent formulations on the same sizes. It can be said that, within limits, the concentration of parathion is not of as much consequence on finer-mesh attapulgite granules as on coarser-mesh attapulgite granules.

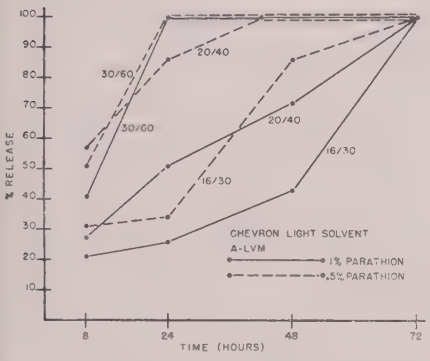


Fig. 2.—Release of parathion into water as related to its concentration using three grades of impregnated granular formulations. The parathion solution was impregnated on A-LVM attapulgite granules and tested at 0.01 p.p.m. in the cups.

The concentration-release relationship of coated parathion granules was also studied. One, 2 and 5 percent formulations were evaluated at 2 p.p.m. concentration in the jars and 0.01 p.p.m. concentration in the cups (Fig. 3). The over-all magnitude of release from the 1 percent formulation was slightly greater than from the 2 and 5 percent formulations, even though at the 8-hour interval the release was less than that from the other formulations.

The differences in the magnitude of releases of these three coated granular formulations are not too great. The 1, 2, and 5 percent impregnated formulations prepared with Chevron Light Solvent also indicated a similar trend (see Fig. 1). Slight differences may be due to experimental variations. It is possible that higher concentration formulations (e.g., 10 percent) of the coated granules may result in marked reduced release of parathion as was observed for the impregnated granules (see Fig. 1).

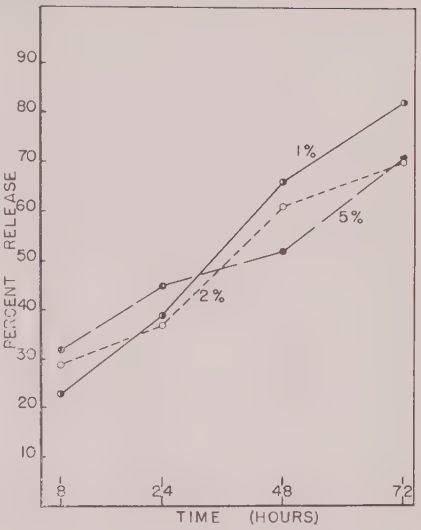


Fig. 3.—Release of parathion into water as related to its concentration in coated granular formulations. All the formulations were graded to be 20/28 mesh.

Rate of Application and Release of Parathion.—The percent release of parathion from granular formulations was believed to be influenced by the rate of application. To obtain experimental evidence on this phase of the work, attapulgite granules (30/60 AA-LVM) were impregnated with parathion using Chevron Light Solvent and AR-60 as solvents. The granules were added to water in the mayonnaise jars to yield theoretical concentrations of 0.5, 1.0, 2.0, and 5.0 p.p.m. of parathion. Aliquots of water were tested at 0.015 and 0.0125 p.p.m. in the cups for the Chevron Light Solvent formulation and at 0.04 p.p.m. in the cups for the AR-60 formulation.

The patterns of release for the Chevron Light Solvent formulation at the 0.5 and 1.0 p.p.m. rates tested at 0.015 and 0.0125 p.p.m. concentrations in the cups were essentially the same (Fig. 4). Although the release for the 0.5 and 1.0 p.p.m. rates calculated at the 0.015 p.p.m. concentration

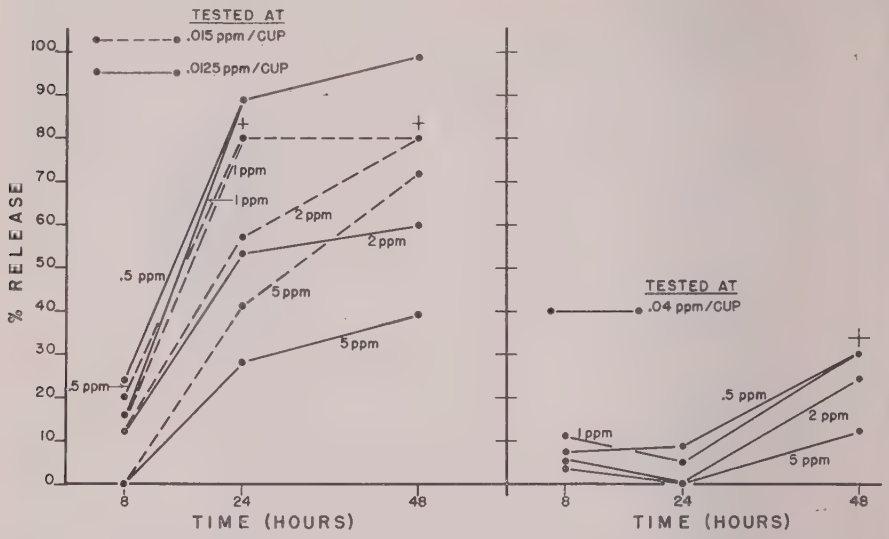


FIG. 4.—Release of parathion into water from its 2 percent impregnated attapulgite (30/60 AA-LVM) granular formulations, applied at various rates. Formulation on the left was prepared with Chevron Light Solvent and the one on the right was prepared with AR-60 solvent.

in the cup was lower than the release at the 0.0125 p.p.m. concentration, the plus sign (+) would place the release for the higher concentration in line with the lower concentration. The release for the 2.0 and 5.0 p.p.m. rates was found to be markedly different from the release for other rates at both the 0.015 and 0.0125 p.p.m. concentrations. The 0.015 p.p.m. concentration level in both the 2.0 and 5.0 p.p.m. rates yielded higher releases than the 0.0125 p.p.m. concentrations; this trend was expected.

Release from the AR-60 formulation was very low at all rates. An inverse relationship between the rate of application and the release of parathion is obvious. The 0.5 and 1.0 p.p.m. rates yielded similar results.

In practice the rate of application of parathion for effective mosquito control is less than 1.0 p.p.m. Therefore, a variation in the rate of application at this concentration or at a lower level may not be of great importance. However, the rate of application may be critical for some other granular insecticides that must be used at higher dosages in order to obtain efficient control of mosquitoes.

DDT Granules Against Eye Gnats.—DDT spray and 10 and 30 percent coated DDT granules were evaluated as soil treatments against the eye gnat *H. collusor* at the rate of 20 pounds actual DDT per acre. Both granular formulations resulted in poor reduction of the emerging eye gnats, initially as well as one month and three months after storage (Table 1). The spray treatments proved more effective at all three intervals.

The effectiveness of the 10 percent granular formulation increased on storage and was higher at all testing intervals than that of the 30 percent formulation. The latter formulation also increased in effectiveness three months after storage, but the over-all effectiveness was lower than that of the 10 percent formulation.

It has been realized that DDT granular formulations manifest increased activity in soil as time elapses. However, the lower effectiveness for the first 3 months, or for longer periods, discourages the use of these formulations for eye gnat control.

TABLE 1.—Effectiveness of spray and granular formulations of DDT applied to soil at the rate of 20 lbs. toxicant per acre against the eye gnat *H. collusor*

Treatment and formulation	Average no. gnats/jar and % reduction after (months)					
	0		1		3	
	Gnats/jar	% reduction	Gnats/jar	% reduction	Gnats/jar	% reduction
Emulsion conc.[1] (2 lbs./gal.)	2	98	1	99	27	78
10% coated [2] granules	83	16	72	36	80	33
30% coated [2] granules	85	13	101	10	89	25
Control	98	—	112	—	119	—

[1] The spray was applied at the rate of 100 gallons per acre.

[2] The granule size was 20/28 mesh. The granules were prepared by coating attapulgite wettable powder of DDT onto sand cores, using water-soluble glue.

It seems that there is a great need for the development of improved and fast-acting impregnated and coated DDT granular formulations to be used as soil treatments for the control of *Hippelatès* eye gnats.

References Cited

LABRECQUE, G. C., NOE, J. R., and GAHAN, J. B. 1956. Effectiveness of insecticides on granular clay carriers against mosquito larvae. Mosquito News 16(1):1–3.

MULLA, MIR S. 1960a. Chlorinated hydrocarbon insecticides as soil treatments against the eye gnat *Hippelates collusor* (Townsend) in the laboratory. Jour. Econ. Ent. 53(3):367–72.

MULLA, MIR S. 1960b. Some factors regulating the effectiveness of granular insecticides in mosquito control. Mosquito News 20(3):262–7.

MULLA, MIR S. 1961. Control of *Hippelates* eye gnats with soil treatments using organochlorine insecticides. Jour. Econ. Ent. (in press).

MULLA, MIR S., and AXELROD, HAROLD. 1960. Efficiency of granulated insecticides influenced by solvents used for impregnation. Jour. Econ. Ent. 53(5):938–49.

WEIDHAAS, D. E. 1957. Laboratory study of the release of some organic phosphorus insecticides into water from granular formulations. Mosquito News 17(3):168–72.

WHITEHEAD, F. E. 1951. Rice field mosquito control by pellet-borne insecticides. Arkansas Agr. Expt. Sta. Bull. 511. 30 pp.

UTAH MOSQUITO ABATEMENT ASSOCIATION

Sixty per cent of the people in the state of Utah are now living within the boundaries of organized mosquito abatement districts.

President	*Vice-President*	*Sec.-Treas.*
KARL L. JOSEPHSON	MORRIS F. SWAPP	GLEN C. COLLETT
Box Elder Co. M.A.D.	Davis Co. M.A.D.	Salt Lake City M.A.D.
Brigham City, Utah	Bountiful, Utah	401 City-County Bldg.
		Salt Lake City, Utah

Proceedings of Annual Meetings for Sale.

SUSCEPTIBILITY OF *ANOPHELES ALBIMANUS* TO PRIMATE AND AVIAN MALARIAS

DON E. EYLES

U. S. Department of Health, Education and Welfare, Public Health Service, National Institutes of Health, National Institute of Allergy and Infectious Diseases, Laboratory of Parasite Chemotherapy *

INTRODUCTION. In our experimental studies on monkey and avian malarias, it has been necessary to seek efficient vectors for the various species. Except for the report of Clark and Dunn (1) of a few mosquitoes experimentally infected with *Plasmodium brasilianum,* we could not obtain any information on the susceptibility of *Anopheles albimanus* to species of malaria other than those of man.

Since *A. albimanus* is readily maintained in an insectary and lives well under laboratory conditions, we have tried it on several species of malaria and have compared it with other vectors. This report describes the degree to which *A. albimanus* is susceptible to *Plasmodium cynomolgi* subspecies *bastianellii,* and *P. inui* in rhesus monkeys *(Macaca mulatta)* and to *P. gallinaceum* in the chicken. A note on *Anopheles freeborni* and *P. gallinaceum* is also included.

METHODS. *Anopheles albimanus* eggs were obtained from Dr. H. G. Simkover of the Shell Development Company, to whom we are indebted. The mosquitoes thrived in the insectary.

Plasmodium cynomolgi subspecies *bastianellii* and *P. inui* were maintained in rhesus monkeys. The feedings on *P. inui* were done on infected, splenectomized monkeys as splenectomized monkeys develop more intense parasitemias. Mosquitoes were fed when gametocytes were present in blood smears. The infections in *A. albimanus* were compared with infections in companion lots of *A. quadrimaculatus.* The lots of the two species were fed consecutively on the monkeys with as little delay as possible.

P. gallinaceum was maintained in various breeds of domestic chickens. The infections in *A. albimanus* were compared with infections in *Aedes aegypti.* One lot of *A. freeborni* was also fed on a chicken with *P. gallinaceum.*

Progress of the mosquito infections was followed by the examination of dissected midguts about a week after feeding. If oöcysts were found on the guts, the remainder of the lots (if any remained) were kept for transmission attempts. Transmission was attempted by the injection of dissected salivary glands, as most of the infections in *A. albimanus* were of a low grade, and transmission by bite would have been less certain.

OBSERVATIONS. *Plasmodium cynomolgi bastianelli:* Fourteen lots of *A. albimanus* were fed on monkeys infected with this species of malaria. For comparison, lots of *A. quadrimaculatus* were fed on the same monkeys. The results of the comparisons are summarized in Table 1.

It is evident that under the conditions of our experiments, *A. albimanus* is nearly insusceptible to *P. cynomolgi bastianellii.* Ten of the 14 lots showed no infection whereas the comparable lots of *A. quadrimaculatus* were lightly to moderately infected. The four lots which contained a few lightly infected *A. albimanus* were fed under the most auspicious circumstances. This is shown by the heavy infections obtained in the companion lots of *A. quadrimaculatus,* the mosquitoes of which bore an average of 65 to 469 oöcysts per midgut.

There were 22 mosquitoes of the *A. albimanus* Lot No. 275 remaining after midgut dissection. The glands of these were removed on the 14th day after feeding and injected intravenously into an

* From the Section on Cytology, located at the Medical School of the University of Tennessee, 874 Union Avenue, Memphis 3, Tennessee.

TABLE 1.—A comparison of the susceptibility of *Anopheles albimanus* and *A. quadrimaculatus* to infection with *Plasmodium cynomolgi bastianellii*

Anopheles albimanus				*Anopheles quadrimaculatus*			
Lot No.	No. dissected	Percent infected	Average oöcysts*	Lot No.	No. dissected	Percent infected	Average oöcysts*
247	17	0	0	246	20	55	12
252	18	0	0	251	20	45	16
255	21	0	0	254	20	55	7
257	8	0	0	256	10	70	34
260	17	0	0	261	20	85	26
275	24	8	0.2	274	10	90	469
278	22	0	0	277	10	90	24
280	20	0	0	281	10	50	4
296	20	5	0.1	295	10	90	358
298	20	0	0	297	11	63	8
301	20	5	0.2	300	10	90	129
302	20	5	4	303	10	70	65
306	20	0	0	307	10	60	11
310	19	0	0	311	12	30	3
All lots	266	2.1	—	All lots	183	65	—

* Average oöcysts per mosquito midgut.

uninfected monkey to determine if transmission would result. In addition, 31 mosquitoes of Lot No. 278 were also injected in spite of the fact that no oöcysts had been seen when the midguts were examined. The monkey which received these glands became infected, showing 5,925 parasites per mm.^{3} on the 16th day after inoculation. This is the first record of the transmission of a simian malaria by *A. albimanus*.

Plasmodium inui. Seven lots of *A. albimanus* were fed on splenectomized monkeys infected with *P. inui*. Companion lots of *A. quadrimaculatus* were fed for comparison as is shown in Table 2. Two of the seven lots showed very light infection of the *A. quadrimaculatus* mosquitoes but no infections among the corresponding *A. albimanus*. One infected *A. albimanus* mosquito was found in one lot, but no infected mosquitoes were found in the corresponding *A. quadrimaculatus* lot.

Even though it was demonstrated that *A. albimanus* can become infected with *P. inui*, it is obviously not superior to *A. quadrimaculatus*. Neither mosquito appears to be an efficient vector of this species;

TABLE 2. Comparison of the susceptibility of *Anopheles albimanus* and *A. quadrimaculatus* to infection with *Plasmodium inui*

Anopheles albimanus				*Anopheles quadrimaculatus*			
Lot No.	No. dissected	Percent infected	Average oöcysts*	Lot No.	No. dissected	Percent infected	Average oöcysts*
283	20	0	0	284	22	9	0.1
287	20	0	0	284	20	5	0.1
290	20	0	0	289	18	0	0
291	20	5	0.1	292	20	0	0
308	20	0	0	309	20	0	0
315	20	0	0	314	10	0	0
322	20	0	0	323	20	0	0
All lots	140	0.7	–	All lots	130	2.3	–

* Average oöcysts per mosquito midgut.

however, low gametocyte counts may have contributed to the lack of success.

No transmission trials were attempted.

Plasmodium gallinaceum. It was previously known that several species of *Anopheles* could become infected with *P. gallinaceum.* Table 3 summarizes the results of five feedings of *A. albimanus* on this species. For comparison, lots of *Aedes aegypti* were fed on the same infected chickens.

TABLE 3.—Comparison of the susceptibility of *Anopheles albimanus* and *Aedes aegypti* to infection with *Plasmodium gallinaceum*

Anopheles albimanus				*Aedes aegypti*			
Lot No.	No. dissected	Percent infected	Average oöcysts*	Lot No.	No. dissected	Percent infected	Average oöcysts*
265	21	5	0.2	266	10	90	84
269	18	0	0	267	10	70	39
277	10	20	1.9	276	12	100	41
305	19	0	0	304	10	70	18
325	20	10	6.2	326	10	100	100
All lots	88	6.0	—	All lots	52	87	—

* Average oöcysts per mosquito midgut.

All of the *A. aegypti* lots became infected and the oöcyst counts ran on the average from 17 to 99 oöcysts per midgut. Three of the five *A. albimanus* lots also showed infection but the oöcyst counts were very low and only a small proportion of the mosquitoes bore cysts.

Oöcysts on the *albimanus* midguts were smaller and less advanced in development than those seen in *A. aegypti.* Transmission was not effected when nine pairs of dissected glands from *A. albimanus* Lot No. 277 were injected subcutaneously into an uninfected chicken.

One lot of *A. freeborni* was fed on *P. gallinaceum.* This feeding was coupled with those of the last comparison of Table 3. Sixty percent of the mosquitoes became infected with an average of 95 oöcysts per midgut. The infection was similar in intensity to that found in *Aedes aegypti* fed on the same chicken (lot no. 326).

Eleven pairs of glands were dissected from mosquitoes of this lot 14 days after infection, and were injected subcutaneously into an uninfected chicken. This chicken showed parasites eight days later. This is the first demonstration that *A. freeborni* may serve as an experimental transmitter of *P. gallinaceum;* however, oöcysts on the midgut have been noted previously (2).

DISCUSSION. The main purpose of the experiments described was to make a selection of mosquitoes for experimental studies on malaria. These results are made available for those who may require such information.

A. albimanus was found nearly useless as a practical experimental vector of all of the species of malaria tried. Previous experimental work with this species has shown it to be an efficient transmitter of coindigenous *Plasmodium falciparum,* but a poor transmitter of strains of *P. falciparum* from other regions (3, 4). Other work with this species has indicated that it is not an efficient vector of other strains of human malarias except for coindigenous strains of *P. vivax* and *P. ovale* (5, 8).

The lack of success with *Plasmodium inui* parallels the lack of success of many investigators in finding mosquito hosts of this species. Garnham did succeed in obtaining good infections in *Anopheles atroparvus* (6) and previously we have found moderate infections in *A. freeborni* (7).

In the future we hope to use *A. albimanus* in attempts to transmit *Plasmodium*

brasilianum with which it is coindigenous, but so far we have been unable to obtain a strain of the latter.

SUMMARY. *Anopheles albimanus,* as compared with *A. quadrimaculatus,* was an inefficient experimental vector of *Plasmodium cynomolgi bastianellii,* but transmission was accomplished with this species.

Neither *A. albimanus* nor *A. quadrimaculatus* appeared to be efficient vectors of *Plasmodium inui.*

A. albimanus showed midgut infections with oöcysts of *P. gallinaceum* in a few instances, but there were fewer oöcysts than in *Aedes aegypti* and they appeared retarded in their development. One attempt at transmission failed.

A. freeborni became infected with *P. gallinaceum* and transmission was accomplished.

References

1. CLARK, H. C. and DUNN, L. H. 1931. Experimental efforts to transfer monkey malaria to man. Am. J. Trop. Med., 11(1):1–7.

2. EYLES, D. E. 1952. Studies on *Plasmodium gallinaceum.* IV. A comparison of the susceptibility of *Aedes aegypti, Anopheles quadrimaculatus* and *Anopheles freeborni.* Am. J. Hyg., 56(1): 71–77.

3. JEFFERY, G. M., EYLES, D. E., and YOUNG, M. D. 1950. The comparative susceptibility of *Anopheles quadrimaculatus* and two strains of *Anopheles albimanus* to a Panama strain of *Plasmodium falciparum.* J. Nat. Malaria Soc., 9(4): 349–355.

4. EYLES, D. E., and YOUNG, M. D. 1950. The comparative susceptibility of *Anopheles albimanus* and *Anopheles quadrimaculatus* to a South Carolina strain of *Plasmodium falciparum.* J. Inf. Dis., 87:189–193.

5. YOUNG, M. D. 1948. Adaptability of exotic malaria parasites to indigenous anophelines. Proc. Fourth Int. Congr. Trop. Med. and Malaria, 1: 672–680.

6. GARNHAM, P. C. C. 1951. The mosquito transmission of *Plasmodium inui* Halberstaedter and Prowazek, and its pre-erythrocytic development in the liver of the Rhesus monkey. Trans. Royal Soc. Trop. Med. and Hyg., 45(1):45–52.

7. EYLES, D. E. 1960. *Anopheles freeborni* and *A. quadrimaculatus* experimental vectors of *Plasmodium cynomolgi* and *P. inui.* J. Parasit., in press.

8. JEFFERY, G. M. 1954. The Donaldson strain of malaria. 3. The infection in the mosquito. Am. J. Trop. Med. and Hyg., 3:651–659.

CONTROL OF *CULICOIDES* (DIPTERA: HELEIDAE) IN SMALL PLOTS ON CAPE COD, MASSACHUSETTS [1]

W. J. WALL, JR.[2]

Cape Cod Mosquito Control Project

INTRODUCTION

Three species of bloodsucking gnats are known to breed in large numbers in salt water habitats along the eastern seaboard. The larvae of two species, *Culicoides canithorax* Hoffman and *C. furens* (Poey) have been found breeding in the mud of tidal marshes, and the third, *C. melleus* (Coq.), has been taken from intertidal sand on Cape Cod (Wall and Doane 1960).

During the past decade, a variety of chemical compounds have been employed in attempts to control *C. canithorax* and *C. furens* in Florida. These compounds include: dieldrin, aldrin, chlordane, malathion, heptachlor, ansenites, arsenates, benzene hexachloride and oils (Goulding *et al.,* 1953, Keller *et al.,* 1954, Labrecque 1954, Smith *et al.,* 1959). Jamnback *et al.*

[1] From the Proceedings of the 16th Annual Meeting of the AMCA, March 27–30, 1960, in Boston, Massachusetts.

[2] Permanent address: State Teachers College, Bridgewater, Massachusetts.

(1958) have reported control of *C. melleus* larvae in small plots on Long Island using DDT emulsion. Smith *et al.* (1959) used dieldrin on a large scale against this same species in Florida.

Considerable success in temporary control of all three species has been reported by most of the above cited individuals. In many instances, however, particularly in recent years, heavy dosages of insecticides were found essential to achieve this success. It is quite apparent, as shown by Smith *et al.* (1959) that in areas such as Florida, where large scale insecticidal control programs have been in progress for many years, resistance to certain insecticides is present in the sand fly populations.

Our approach to undertaking a large scale *Culicoides* control program on Cape Cod was influenced by the following factors: (1) a consideration of the probability of insecticidal resistance appearing in the future; (2) the continual pressure of conservation agencies to limit or prohibit the use of large scale aircraft insecticidal applications because of possible damage to other fauna; and (3) the limited funds available to our control project.

Before any large scale control of our annoying species of *Culicoides* was undertaken, therefore, we set out to determine the minimum effective dosage of insecticide that would prove successful in reducing larval population at a minimum cost without causing undue damage to other fauna.

CONTROL OF *C. melleus*

METHODS AND MATERIALS. The original test sites were located on protected sandy beaches having high and relatively uniform *C. melleus* populations. The width of each plot extended from low tide level to above high tide level and uniform plots 25 yards in length and 8 yards in width were employed. The insecticides were distributed at about low tide. Chemicals used in spray form were put on from a 2.5 gallon spray can and the granular material (Attaclay) was broadcast by hand. The plots were sprayed along one axis only to simulate conditions of aerial application. Sampling procedure was that employed by Jamnback and Wall (1958) and larval samples were taken immediately before treatment, one or two days after treatment and fourteen days after treatment. The results of these tests are summarized in Table 1.

RESULTS AND DISCUSSION. Dieldrin appeared to be the most effective of the chemicals employed at a dosage of 0.1 pound per acre.[3] In emulsion form at 0.1 to 0.2 pounds per acre, dieldrin produced better results than the granular form at 0.4 pound per acre, although we believe that this was due to difficulties in obtaining uniform distribution by hand broadcasting the granular material.

The results of larval control with fuel oil appeared very encouraging during the first few days following spray application. By the end of two weeks, however, it was obvious that only about 50 percent control had been attained with the oil spray. When DDT in oil was employed at the minimum dosage of 0.5 pound per acre, excellent control was noted by the second week following spray application. It is rather difficult to account for the complete control recorded the second day following spray application when 0.5 pound of DDT oil was applied as compared to 78.6 percent control at 1.0 pound of DDT-oil per acre. It is possible that better distribution of the spray was obtained or better penetration of the sand was realized in the former case. DDT emulsion was also very effective at 1.0 pound per acre although not so effective as the DDT-oil mixtures. BHC emulsion applied at the rate of 0.1 pound of gamma isomer per acre was very effective, but it was much less effective at one half this dosage.

Chlordane applied as a wettable powder at the rate of 1.0 pound per acre provided satisfactory control while malathion applied in this same form at the rate of 0.5 pound per acre was relatively ineffective. Each of these materials might have been more satisfactory in emulsion form.

[3] All dosages given refer to the amount of technical insecticide applied.

TABLE 1.—Results of insecticide tests against *C. melleus* larvae in small plots

Insecticide	Dosage (technical) lbs./acre	No. days after treatment	Average number of larvae		Percent reduction*
			Treated plot	Check plot	
Malathion (wettable)	0.5	(before tr.)	26.0(3)†	21(1)	——
		2	11.0(3)	21(1)	57.7
		14	23.0(6)	13(1)	(increase)
Chlordane (wettable)	1.0	(before tr.)	40.6(3)	33(1)	——
		2	9.3(3)	33(1)	77.1
		14	7.0(3)	41(1)	86.1
Dieldrin (granular)	0.4	(before tr.)	24.3(3)	34(1)	——
		2	3.0(3)	36(1)	88.3
		14	3.7(3)	31(1)	83.3
Dieldrin (emulsion)	0.2	(before tr.)	39.5(2)	28(1)	——
		2	0.5(4)	24(2)	98.5
		14	0.3(3)	14(1)	98.5
Dieldrin (emulsion)	0.1	(before tr.)	50.0(3)	50(1)	——
		1	0.0(3)	50(1)	100.0
		14	0.0(3)	50(1)	100.0
Fuel Oil (#2)	(1 quart)	(before tr.)	30.0(3)	50(1)	——
		2	5.0(3)	43(1)	80.6
		14	15.3(3)	50(1)	49.0
DDT in Fuel Oil	1.0 (1 quart)	(before tr.)	46.7(3)	50(1)	——
		2	10.0(3)	50(1)	78.6
		14	0.3(3)	50(1)	99.4
DDT in Fuel Oil	0.5 (1 quart)	(before tr.)	48.3(3)	50(1)	——
		1	0.0(3)	50(1)	100.0
		14	0.3(3)	50(1)	99.4
DDT (emulsion)	1.0	(before tr.)	50.0(3)	50(1)	——
		1	0.0(3)	50(1)	100.0
		14	4.0(3)	50(1)	92.0
BHC (emulsion)	0.1 (gamma isomer)	(before tr.)	28.0(3)	40(1)	——
		2	0.0(3)	48(1)	100.0
		14	0.3(3)	25(1)	98.3
BHC (emulsion)	0.05 (gamma isomer)	(before tr.)	50.0(3)	50(1)	——
		2	25.7(3)	50(1)	48.6
		14	30.6(3)	50(1)	38.8

* Abbott's formula.
† Number of samples averaged given in parentheses.

Many active annelids, insects and crustaceans were present in the treated areas up to 14 days following treatment. Oil-treated areas were also carefully observed, and it was noted that all traces of oil had disappeared from the beach sand by the end of the first to second weeks following application.

Two large stretches of intertidal sand were sprayed by helicopter with DDT emulsion and two with DDT oil spray to determine the feasibility of this method of application. Excellent distribution of the spray material resulted in all cases even when large numbers of small boats and sailing craft were anchored in the immediate vicinity of the treated areas.

Control of *C. canithorax* and *C. furens*

Materials and Methods. In the second series of experiments, plots 25 by 8 yards were selected in a salt marsh where prior sampling gave good larval counts. The sites selected included mosquito ditches

and bay front areas where previous investigation indicated the majority of larvae are located (Wall and Doane 1960). The sampling procedure employed was that of Bidlingmayer (1959) as modified by Wall and Doane (1960). The plots were sprayed from a 2.5 gallon spray can along one axis only. The results of the tests are given in Table 2.

uniform distribution of spray materials on the marsh soil. We feel, therefore, that similar dosages of insecticides applied in granular form would prove more effective in penetrating the marsh grass cover and contacting the larvae.

Annelids of the family Naididae were active in the treated plots up to 14 days following treatment and no noticeable

TABLE 2.—Results of insecticide tests against *C. canithorax* and *C. furens* larvae in small plots

Insecticide	Dosage (technical) lbs./acre	No. days after treatment	Average number of larvae		Percent reduction*
			Treated plot	Check plot	
Dieldrin (emulsion)	0.1	(before tr.)	19.3(3)†	50.0(1)	——
		1	3.0(3)	44.5(2)	82.5
		14	2.8(5)	50.0(1)	85.5
BHC (emulsion)	0.1 (gamma isomer)	(before tr.)	30.5(2)	50.0(1)	——
		1	2.3(3)	44.5(2)	91.5
		14	4.4(5)	50.0(1)	85.6
DDT (emulsion)	1.0	(before tr.)	14.6(3)	50.0(1)	——
		1	0.0(3)	44.5(2)	100.0
		14	1.6(3)	50.0(1)	89.0

* Abbott's formula.
† Number of samples averaged given in parentheses.

RESULTS AND DISCUSSION. During the late spring, summer and early fall, the breeding areas of *C. canithorax* and *C. furens* are characterized by the presence of heavy stands of marsh grasses, principally *Spartina alterniflora* and *S. patens*. The former becomes very long and dense along the ditches, creeks and bay fronts, and the presence of the marsh grasses makes it very difficult for the spray application to reach the soil surface. In addition to the grasses, the uneven surface and numerous fiddler crab holes create further barriers to uniform spray distribution and larval contact with the insecticide.

In spite of these factors, however, it can readily be seen from Table 2 that all three insecticides at low concentrations were quite effective in temporarily reducing the larval populations in the marsh mud for a period of 14 days. Although the insecticides employed were not so effective as they were against the *C. melleus* larvae, it is our opinion that this was due to the difficulties encountered in obtaining damage to other fauna such as fiddler crabs was apparent.

A total of 684 *Culicoides* larvae taken from the salt marsh test sites during the summers of 1958–59 were identified and of this number, approximately 96 percent were *C. canithorax* and 4 percent *C. furens*. These findings were further substantiated by collecting adult dark winged gnats biting or walking on the body during the daytime and early evening in or adjacent to the marshes during these same two summers. A total of 337 specimens were identified and the results were identical to those above.

SUMMARY

Control of *Culicoides melleus* in small intertidal plots was carried out on Cape Cod. Dieldrin in emulsion form was completely effective when applied at 0.1 pound per acre, but in granular form at the rate of 0.4 pound per acre it was somewhat less effective. Fuel

oil cut larval populations approximately in half and DDT oil mixtures at 1.0 and 0.5 pounds per acre produced excellent results. DDT emulsion at 1.0 pound per acre and BHC emulsion applied at a dosage of 0.1 pound of gamma isomer were also very effective. Chlordane wettable powder gave good results at 1.0 pound per acre while malathion wettable powder applied at the rate of 0.5 pound per acre was rather ineffective.

Many annelids, insects and crustaceans were active in treated plots following spray application and oil residues had disappeared by the end of the first to second week after treatment. Large stretches of intertidal sand were sprayed by helicopter and excellent distribution was obtained.

Small plots in a salt marsh were treated with dieldrin and BHC emulsions at 0.1 pound and DDT at 1.0 pound per acre. DDT appeared to be the most effective larvicide although all three gave good larval control under conditions of summer application. Larval samples taken from the test plots were 96 percent *C. canithorax* and 4 percent *C. furens*. These findings were substantiated by counts taken of adults biting or walking on the body surface. Naidid worms and fiddler crabs were active in the salt marsh test plots up to 14 days following treatment.

Acknowledgment

Thanks are expressed to Mr. O. W. Doane, Jr., Cape Cod Mosquito Control Project for his assistance in collecting the adult *Culicoides,* to Dr. A. W. Bell, Los Angeles City College for his identification of the naidid worms, and to Dr. W. W. Wirth, United States Department of Agriculture for his identification of representative larvae and adult *Culicoides.*

References Cited

Bidlingmayer, A. L. 1957. Studies on *Culicoides furens* (Poey) at Vero Beach. Mosquito News 17(4):292–294.

Goulding, R. L., Curran, R. F., and Labrecque, G. C. 1953. Insecticides for control of salt-marsh sand flies in Florida. Jour. Econ. Ent. 46(1):37–43.

Jamnback, H., and Wall, W. J. 1958. A sampling procedure for *Culicoides melleus* (Coq.) (Diptera: Heleidae) with observations on the life history of two coastal *Culicoides*. Mosq. News 18 (2):85–88.

———, Wall, W. J., and Collins, D. L. 1958. Control of *Culicoides melleus* (Coq.) (Diptera: Heleidae) in small plots, with brief descriptions of the larvae and pupae of two coastal *Culicoides*. Mosq. News 18(2):64–70.

Keli er, J. C., Labrecque, G. C. and Goulding, R. L. 1954. Tests with heptachlor and dieldrin for the control of sand fly larvae. Proc. Florida Anti-Mosquito Assoc. 25th Ann. Meeting, pp. 95–99.

Labrecque, G. C. 1954. Tests with granulated BHC and dieldrin for controlling sand fly larvae. Mosq. News 14(1):20–22.

Smith, C. N., Davis, A. N., Weidhaas, D. E., and Seabrook, E. L. 1959. Insecticide resistance in the salt-marsh sand fly, *Culicoides furens*. Jour. Econ. Ent. 52(2):352–353.

Wall, W. J., and Doane, O. W. 1960. A preliminary study of the bloodsucking Diptera on Cape Cod, Massachusetts. Mosq. News 20(1): 39–44.

ILLINOIS MOSQUITO CONTROL ASSOCIATION

EXECUTIVE COMMITTEE

President
DR. G. F. OTTO
Lake Bluff Mosquito
Abatement District
Lake Bluff, Illinois

Past President
Wilbur Mitchell
Northwest Mosquito
Abatement District
Wheeling, Illinois

Member
Francis P. Creadon
DesPlaines Valley Mosquito
Abatement District
Lyons, Illinois

Vice-President
Leo Michl
Decatur City Health Dept.
County Building
Decatur, Illinois

Member
Brice E. Johns
South Cook County
Mosquito Abatement Dist.
Harvey, Illinois

Secretary-Treasurer
Harvey J. Dominick
Illinois Dept. of Public Health
Division of Sanitary Engineering
Springfield, Illinois

LONGEVITY OF INSECTICIDES IN SOIL AS TESTED AGAINST THE EYE GNAT *HIPPELATES COLLUSOR*[1]

MIR S. MULLA

University of California Citrus Experiment Station, Riverside

INTRODUCTION. *Hippelates* eye gnats breed principally in cultivated agricultural land composed of loose and friable soil. They breed to a lesser degree in non-cultivated irrigated land. The normal agricultural practices such as tillage, irrigation, availability of decaying organic matter and disking under cover crops for conditioning of the soil provide ideal conditions for gnat breeding. The adult eye gnats disperse from the breeding grounds and fly to residential and recreational areas, annoying man and domestic animals.

At the present time, a practical approach toward controlling eye gnats in their breeding grounds consists of incorporating residual larvicides into the soil where the gnats are breeding. Selection of a suitable eye gnat larvicide is dictated by factors such as initial effectiveness, residual activity, disappearance of the material from the soil surface before disking in, and side effects of the larvicide on crop plants.

Gathering data on the performance of a larvicide in the field is a tedious task and often a very expensive one. Valuable information on the effectiveness and longevity of larvicides, however, can be readily obtained in the laboratory. Promising materials can thus be singled out for field experimentation against eye gnats.

The effectiveness of organochlorine and organophosphorus insecticides as soil treatments against the eye gnat *H. collusor* was determined in the laboratory (Mulla, 1960a, 1961a). Similarly the loss of activity of the most active organochlorine insecticides in soil against the eye gnat was studied (Mulla, 1960b). Loss of some of these insecticides from soil surface prior to disking under in the field was determined (Mulla, 1960c). As a result of all these studies, DDT, endrin and Shell Development Compound SD-4402 were the only organochlorine insecticides singled out for field trials. Field investigations on these and other materials demonstrated that DDT yielded better and longer control of eye gnats than the other organochlorine insecticides evaluated (Mulla *et al.*, 1960, Mulla, 1961b).

Studies on the initial effectiveness of 27 organophosphorus and carbamate insecticides as soil treatments against *H. collusor* (Mulla, 1961a) showed many of these insecticides to have a high degree of biological activity. However, information on residual activity is also necessary to determine which materials are most promising for use in field trials. Preliminary studies on the longevity of 12 insecticides (9 organophosphorus, 2 carbamate and 1 organochlorine) in soil are reported. Detailed studies on the residual activity of some of these and other insecticides are under way.

METHODS AND MATERIALS. Three 1-gallon quantities (11.5 pounds) of Coachella fine sand (containing 0.15 percent organic matter) were treated with each material listed in Table 2. The amount of soil treated with each material listed in Table 3 was one-half gallon. After treatment the soil was thoroughly mixed and transferred to either one or one-half gallon jars. Prior to storage, water was added to the soil in the jars to obtain an initial moisture content of 13 percent, dry weight basis. The jars were covered with muslin cloth and stored in a greenhouse at 88° ± 2° F.

At 2-month intervals, additional water was added to the soil treated with materials listed in Table 2 to maintain the moisture content at 13 percent. The soil treated

[1] These studies were partially supported by a grant-in-aid from the Coachella Valley Mosquito Abatement District, Riverside County, California. Paper No. 1236, University of California Citrus Experiment Station, Riverside, California.

with the materials listed in Table 1 was maintained at lower moisture content and no additional water was added until after 6 months of storage.

To determine the long term activity, quantities of the treated soil to be tested were air-dried and processed in the same manner used to determine the longevity of organochlorine compounds (Mulla, 1960b). Organic matter (56 grams of alfalfa meal, 28 grams of brewer's yeast, and 28 grams of whole-wheat flour per gallon quantity) was added to the soil and mixed thoroughly. The 1-gallon lots were divided into 10 portions and the 1/2-gallon lots were divided into 5 portions, thus yielding 10 replicates and 5 replicates, respectively. Control treatments were also run during each test. Each portion of the processed soil was placed in a narrow-mouthed pint fruit jar. To the pint jars, 140 ml. of water were added, and each jar was seeded with 200 eggs of the eye gnat *H. collusor*. Gnat emergence was recorded and the percent reduction was determined by comparing the insecticidal treatments with the control treatment.

The percent loss for each material and dosage was determined by reading off the amount of toxicant corresponding to a certain reduction in eye gnat emergence, using the dosage mortality line of the material against the eye gnat (Mulla, 1961a). From the amount of the toxicant present in the soil at the time of testing and the initial amount applied to the soil, it was possible to calculate the percent loss at the testing intervals.

Due to the nature of dosage-response line it was apparent that in cases where the reduction in eye gnat emergence was over 98 percent, the percent loss of a material could not have been adequately determined, although the percent loss could have been appreciable. Reductions in eye gnat emergence over 98 percent are not indicated on the dosage mortality line. Similarly, it was not possible to ascertain the exact losses of materials that produced lower than 5 percent reductions in eye gnat emergence. Reductions of this magnitude could be due to experimental variations. In such cases the apparent losses of materials for practical purposes were considered to be 100 percent.

Results and Discussion. According to previous studies (Mulla, 1961a), Co-Ral, Bayer 25141 (*O,O*-diethyl *O-p*-methyl sulfinylphenyl phosphorothioate), and Bayer 29493 (*O,O*-dimethyl *O*-3-methyl-thiophenyl phosphorothioate) were found to be highly effective against the gnat (Table 1). Therefore, these materials were tested

TABLE 1.—Effectiveness of twelve insecticides as soil treatments against the eye gnat *Hippelates collusor* as determined by their LD_{90} levels in soil

Material	Pounds/acre LD_{90}	Material	Pounds/acre LD_{90}
Co-Ral	0.052	Parathion	4.8
Bayer 25141	0.096	Dimethoate	5.0
Bayer 29493	0.131	AC 5727	10.2
G-30494	0.400	Sevin	20.5
Ethion	1.260	Thiodan	33.0
Guthion	1.300		
Delnav	1.640		

at lower dosages but still several times their initial LD_{90} levels. Geigy Chemical Company compound G-30494, Ethion, Guthion, and Delnav were also highly effective, but with lower activity than the above compounds. Guthion was tested at a relatively low dosage, but the remaining three materials were tested at low to moderate dosages. Parathion and Dimethoate, with moderate activity, were tested at moderate dosages. Hercules Powder Company Compound AC-5727 (*m*-isopropylphenyl N-methylcarbamate), Sevin and Thiodan were studied at relatively higher dosages since the activity of these compounds against the gnat is very low.

Bayer 25141 at 1 pound per acre and Ethion at 6 pounds per acre gave almost complete reduction of eye gnats after 7 months of storage (Table 2). After 13 months, Bayer 25141 caused no reduction in eye gnat emergence and was considered to have lost its activity completely. Ethion at 6 pounds per acre after 15 months caused

TABLE 2.—Longevity of insecticides in soil as tested against the eye gnat *Hippelates collusor* [1]

Insecticide and formulation	Dosage, lbs. tox./acre	Avg. gnat emergence per jar (Gnats/J) and % control after (months)								% loss after (months)			
		(3)		(4)		(7)		(13–15)					
		Gnats/J	% Red.	Gnats/J	% Red.	Gnats/J	% Red.	Gnats/J	% Red.	(3)	(4)	(7)	13–15
Bayer 25141 EC 2	1.0	–	–	2	98	1	99	117	0	–	–	–	100
Ethion EC 4	6.0	0	100	–	–	0	100	10	91	–	–	–	79
AC-5727 EC 1.1	11.0	86	17	–	–	–	–	–	–	81	–		–
	22.0	93	10	–	–	–	–	109	4	93	–	–	100
Dimethoate EC 4	6.0	–	–	104	5	–	–	–	–	–	97	–	–
Parathion EC 2	5.0	103	1	–	–	–	–	–	–	100		–	
Bayer 29493 EC 2	1.5	–	–	93	15	–	–	–	–	–	98	–	–
Co-Ral EC 1.5	0.5	44	57	–	–	–	–	–	–	93	–	–	–
Guthion EC 1.5	1.5	110	0	–	–	–	–	–	–	100		–	–
Control		104	–	109	–	100	–	113	–	–	–	–	–

[1] One-gallon quantities of soil were treated. Initially 700 ml. of water were added per jar. After 6 months 350 ml. of water were added to each of the remaining soil quantities.

good reduction in eye gnat emergence, but 79 percent of the material had been lost. Hercules Powder Company Compound AC-5727, dimethoate, parathion, Bayer 29493, and Guthion lost most or all of their activity after 3 to 4 months of storage. Co-Ral, when applied at 0.5 pound per acre, resulted in a moderate reduction of eye gnats after 3 months of storage but lost 93 percent of its activity.

Geigy Chemical Company Compound G-30494 and Delnav were evaluated at three dosage levels each (Table 3). When tested after 3 months of storage the former compound lost over 90 percent of its activity at all dosage levels and the latter material lost more than half of its activity. Sevin and Thiodan also lost a good portion of their activity after 3 months of storage. Complete loss of activity was ascertained for all five materials, 6 months after start of the storage period.

From these studies it is obvious that Compound AC-5727, Dimethoate, parathion, Bayer 29493, Guthion, Compound G-30494, Sevin, Thiodan, and Delnav would not be suitable for obtaining economical and practical eye gnat control. The information obtained on the longevity of these materials in soil might aid in predicting the suppressing effect on eye gnat populations of these insecticides when they are used as soil treatments for the control of other agricultural pests. Only Bayer 25141, Ethion, and Co-Ral, among all of the materials tested, merit further laboratory and field investigations. These materials have considerable biological activity and are more residual in soil than the other materials.

References Cited

Mulla, Mir S. 1960a. Chlorinated hydrocarbon insecticides as soil treatments against the eye gnat *Hippelates collusor* (Townsend) in the laboratory. Jour. Econ. Ent. 53(3):367–72.

TABLE 3.—Longevity of insecticides in soil as determined by bio-assaying against the eye gnat *Hippelates collusor* [1]

Insecticide and formulation	Dosage, lbs. tox./acre	Avg. no. gnats/jar and % reduction after (months) (3) Gnats/J	(3) % Red.	(6) Gnats/J	(6) % Red.	% loss after (months) (3)	% loss after (months) (6)
G-30494 EC 2	2	94	12	89	0	93	100
	4	64	40	87	0	95	100
	8	44	59	100	0	97	100
Sevin 50% WP	20	72	32	97	0	58	100
Thiodan EC 2	32	61	43	98	0	38	100
Delnav EC 3	2	78	27	89	0	60	100
	4	61	43	84	0	76	100
	8	45	58	89	0	86	100
Control	–	106	—	87	–	—	—

[1] One-half gallon of soil was used per treatment. Prior to storage 350 ml. of water were added to each jar. Subsequently 200 ml. of water were added to each jar every 2 months.

Mulla, Mir S. 1960b. Loss of activity of chlorinated hydrocarbon insecticides in soil as measured against the eye gnat *Hippelates collusor*. Jour. Econ. Ent. 53(5):785–7.

Mulla, Mir S. 1960c. Loss of chlorinated hydrocarbon insecticides from soil surface in the field. Jour. Econ. Ent. 53(4):650–55.

Mulla, Mir S. 1961a. Organophosphorus and carbamate insecticides as soil treatments against the eye gnat *Hippelates collusor* in the laboratory. Jour. Econ. Ent. (In press.)

Mulla, Mir S. 1961b. Control of *Hippelates* eye gnats with soil treatments using organochlorine insecticides. Jour. Econ. Ent. (In press.)

Mulla, Mir S., Barnes, Martin M., and Garber, M. J. 1960. Soil treatments with insecticides for control of the eye gnats *Hippelates collusor* and *H. hermsi*. Jour. Econ. Ent. 53(3): 362–65.

CONTROL MEASURES FOR LOG POND MOSQUITOES IN DOUGLAS COUNTY, OREGON

LOUIS J. OGDEN,[1] LAVERNE S. MILLER,[2] AND JAMES V. SMITH[1]

Recent expansion of the lumbering industry in Oregon has focused attention on mosquito problems in the vicinity of lumber mills and associated processing plants. In 1956, the Oregon State Board of Health estimated that there were 10,000 acres of log ponds and sloughs in Oregon that were used for log storage and handling. In 1959, this estimate was increased to 15,000 acres. The importance of mosquito production in these ponds is enhanced by the proximity of the ponds to population centers that provide manpower for the mills and associated industries. Frequently, the pest mosquito problem becomes so great as to cause work stoppage at the mills and to exert a very serious impact on the health and welfare of human populations concentrated near the mills.

Extensive use has been made of insecticides to control both mosquito adults and larvae in log pond areas. However, results of these repetitive control measures have been erratic and unpredictable. To compound the control problem, field observations by Buehler (1955) indicated that mosquito larvae in a log pond at Oakridge, Oregon were resistant to DDT. This resistance was corroborated by Eddy *et al.* (1958). Hoffman and Yates (1956) reported on experiments conducted on log ponds over a period of several years. They showed that DDT emulsions applied at rates of 0.04 to 0.2 ppm gave high initial reductions of *Culex tarsalis* and *Culiseta inornata* populations, and that wettable powder treatments of DDT were much less effective. Surface oils were found to provide a good initial kill, but reinfestation occurred more rapidly than with emulsions. Control of *C. tarsalis, Culex pipiens,* and *Culiseta incidens* mosquitoes was obtained with as little as 0.25 pound of DDT or EPN emulsion per acre. The authors indicated, however, that this dosage was probably too little for practical application since reinfestation occurred within 2 weeks.

Field tests by the Entomology Research Division, USDA (Eddy, 1959, and McDuffie *et al.,* 1959) showed that Guthion gave 100 percent initial control but exhibited no residual effect. Parathion granules applied at the rate of 0.25 pound per acre and Dylox at 0.63 pound per acre were less effective.

METHODS. During 1956, the Technology Branch of the Communicable Disease Center, U. S. Public Health Service, initiated cooperative studies with the Douglas County Health Department and the Oregon State Board of Health to evaluate the usefulness of selected organic insecticides as residual and temporary larvicides on log ponds in Douglas County, Oregon. In May, five log ponds were given residual larvicidal treatment with DDT, heptachlor, and dieldrin. Two other ponds were given temporary larvicidal treatments with Dipterex[3] and cresylic acid. Table 1 shows the log ponds that were treated, the area of each, insecticide used, rate of application, and total amount of finished insecticide applied to each pond. Mosquito larvae were present in all of the ponds when the insecticides were applied.

The dieldrin, heptachlor, Dipterex, and cresylic acid emulsions were applied at a tank pressure of 350 psi with a hydraulic-type power sprayer equipped with 200 feet of hose and an adjustable orchard-type spray gun. During the first application of

[1] Technology Branch, Communicable Disease Center, Public Health Service, U. S. Department of Health, Education, and Welfare, Greeley, Colorado.

[2] General Sanitation Section, Division of Sanitation and Engineering, Oregon State Board of Health, Portland, Oregon.

[3] Use of trade names is for identification purposes only and does not constitute endorsement by the Public Health Service.

TABLE 1.—Summary of larvicidal treatments applied to log ponds in Douglas County, Oregon, during 1956

Name and size of log pond	Chemical formulation used and Type of Treatment	Toxicant per acre	Amount of finished insecticide applied
Dodd Lumber Co.; 0.5 acre	25% granular heptachlor; Residual larvicide	5 pounds	20 pounds
Nyberg Lumber Co.; 2.0 acres	Heptachlor emulsifiable concentrate containing 2 lb./gallon; Residual larvicide	5 pounds	150 gallons
Round Prairie Lumber Co.; 4.3 acres	DDT emulsifiable concentrate containing 2 lb. DDT/gallon; Residual larvicide	1st treatment: 10 pounds. 2nd treatment: 11.1 pounds	1st treatment: 245 gallons 2nd treatment: 350 gallons
Lee Preston Lumber Co.; 1.3 acres	10% granular DDT 20–30 mesh attaclay; Residual larvicide	10 pounds	130 pounds
Jay Mark Lumber Co.; 3.0 acres	Dieldrin emulsifiable concentrate containing 1.5 lb. dieldrin/gallon; Residual larvicide	3 pounds	200 gallons
Ten Mile; 1.2 acres	50% water-wettable Dipterex; Temporary larvicide	0.25 pound	100 gallons
Keystone Lumber Co.; 7.0 acres	Cresylic acid (5% phenol coefficient); Temporary larvicide	7.1 gallons	300 gallons

TABLE 2.—Summary of larval mosquito sampling in treated and untreated log ponds in Douglas County, Oregon, 1956

	Average number of larvae and pupae per dip						Percent species composition in untreated ponds			
Larvicide	Dield. emul.	DDT emul.	DDT gran.	Hepta. emul.	Hepta. gran.					
Date treated	5/26	5/25 & 7/28	5/26	5/26	5/28	Six untreated control ponds	*Culex tarsalis*	*Culex pews*	*Culex pipiens*	*Culiseta incidens*
Toxicant, lb./acre	3	10	10	5	5					
Pretreat.	5	19	2	3	*	*				
Week Ending 6/2	–	–	–	–	0	1				
6/9	0	0	0	0	–	1	73	5	4	18
6/16	0	0	0	0	0	1				
6/23	0	0	0	0	0	2	59	0	0	41
6/30	0	0	0	0	0	1				
7/7	0	0	0	0	0	10	53	0	18	29
7/14	0	*	0	*	0	2				
7/21	0	*	4	*	0	13	65	0	12	23
7/28	0	2	4	1	0	15				
8/4	0	0	2	1	*	43	38	30	25	7
8/11	*	0	9	2	*	24				
8/18	0	0	7	4	0	87	14	50	25	11
8/25	*	2	7	2	0	21				
9/1	1	–	3	*	2	81	22	78	0	0

* Less than one larva per dip.

the DDT emulsion, 200 gallons were applied with a hydraulic power sprayer and 45 gallons with a Buffalo Turbine. The Buffalo Turbine was used to spray the middle section of the pond that could not be reached with a hydraulic sprayer. The second application of DDT emulsion was made with a hydraulic power sprayer equipped with a fire-fighting nozzle that would project a solid stream for a distance of approximately 50 feet. Granular DDT was broadcast by hand and with a crank-type seeder. The granular heptachlor was applied to approximately 75 percent of the log pond's surface with a Buffalo Turbine; the remaining area was treated with a hand seeder. Experiences with various methods of chemical application indicated the need for special equipment for applying insecticides to log ponds.

The log ponds were inspected for mosquito larvae with a one-pint white enamel dipper prior to treatment and each week thereafter, to evaluate the effectiveness and duration of the various treatments. During each inspection, ten dips were taken at 6 or more sampling sites in each pond. Wherever possible, the following three ecologically different areas in each pond were dipped: (1) open water, (2) surface litter and floating logs, and (3) marginal vegetation.

RESULTS. Results of the residual larvicidal treatment are summarized in Table 2. It was arbitrarily assumed that control was no longer effective when the average number of larvae per dip was 2 or more. Dieldrin emulsion and granular heptachlor were effective in controlling log pond mosquito larvae for periods of 14 and 13 weeks, respectively. Granular DDT, DDT emulsion, and heptachlor emulsion were effective for about 7, 8, and 10 weeks, respectively. Following retreatment of a log pond with DDT emulsion, no larvae were found during 3 consecutive weekly

FIG. 1.—Log pond in Douglas County, Oregon, having banded logs that make larvicidal operations difficult.

inspections (Table 2). Dipterex was effective as a temporary larvicide, while cresylic acid gave no apparent reduction of mosquito larvae.

On May 29, five hundred pounds of BHC dust containing 2 percent gamma isomer were applied with a Buffalo Turbine to an 18-acre log pond as a combination adulticide-larvicide treatment. Larval inspection 24 hours after application of the BHC dust revealed that larvae in the far side of the pond had not been killed despite the fact that a cloud of insecticide dust passed over that portion of the pond during treatment. The portion of the pond that was not effectively larvicided was sprayed with BHC water-wettable powder by means of a hydraulic-type sprayer. The effective length of this combined treatment was only 23 days. The pond was retreated with BHC water-wettable powder on July 1. The effective period of the second treatment was only 11 days. The lack of residual effectiveness was due primarily to the difficulties in applying the insecticide to the larval mosquito habitats that were exceedingly well protected by surface litter, stored logs (some banded), luxuriant algal growths, and emergent vegetation (Figure 1).

Summary. Heptachlor at 5 pounds per acre, DDT at 10 pounds per acre, and dieldrin at 3 pounds per acre were tested as residual larvicides; Dipterex at ¼ pound per acre and cresylic acid at 7 gallons per acre were tested as temporary larvicides for the control of log pond mosquitoes. Granular heptachlor and dieldrin emulsion were effective in controlling larvae of log pond mosquitoes for periods of 13 and 14 weeks, respectively. Granular DDT, DDT emulsion, and heptachlor emulsion were effective for about 7, 8, and 10 weeks, respectively. Dipterex proved to be an effective temporary larvicide, but cresylic acid gave no apparent reduction in larval mosquito populations. BHC dust had limited residual effectiveness.

Literature Cited

Buehler, M. H. 1955. Third annual report Lane County mosquito control program. Lane County Health Department, Eugene, Oregon.

Eddy, Gaines, W., Hopkins, Theodore L., and Robbins, William E. 1958. Resistance of *Culex tarsalis* Coq. to DDT in Oregon. Jour. Ec. Ent. 51(1):56–58.

Eddy, Gaines W. 1959. Highlights on U.S.D.A.'s research on mosquitoes in 1958. Proc. and Papers Twenty-seventh Ann. Conf. Calif. Mosquito Control Assn., p. 84.

Hoffman, Robert A., and Yates, W. W. 1956. Control of mosquitoes found in log ponds in western Oregon. Mosquito News 16(4):291–293.

McDuffie, W. C., Gahan, J. B., Davis, A. N., and Lewis, L. F. 1959. USDA Mosquito Control Research for 1958. Pest Control 27(4):9.

DESPLAINES VALLEY MOSQUITO ABATEMENT DISTRICT

8130 Ogden Avenue, Lyons, Illinois

Member of American Mosquito Control Association

Trustees

Otto McFeely, President; Charles F. Scheel, Vice-President; John J. Callahan, Secretary; Francis P. Creadon, Treasurer; William E. Goersmeyer, Ass't Secretary.

Franklin C. Wray, Technical Director

The District was created under state law adopted in 1927 by the General Assembly of Illinois. The District has functioned for thirty-two years.

OPERATIONAL AND SCIENTIFIC NOTES

PRESERVATION OF MOSQUITO PUPAE BY THE FREEZE-DRYING TECHNIQUE

JOHN M. WHITE
Dept. of Biology, Del Mar College,
Corpus Christi, Texas

Studies of the structures of the pupae of mosquitoes in many instances are made more difficult by the necessity for making slides. In many cases, the pupae must be separated between the cephalothorax and the abdomen before satisfactory mounts can be prepared. This has the disadvantage of mutilating specimens. Additionally, slides of the pupae are not always easy to study because not all surface aspects of the pupae can be readily observed beneath the microscope.

The following procedure for preparing specimens of mosquito pupae for study has proved to be useful to the author because the difficulties previously mentioned are eliminated.

First, living pupae are removed from the rearing pans or water from which they were collected, and placed for a short time in a stender dish containing tap water. This cleans the specimens. Each specimen is next removed from the stender dish with a pipette and placed in a drop of tap water on a one-half-inch-square piece of kitchen wax paper. The drop of water on the wax paper is reduced by means of a fine pipette until only a thin film of moisture covers the pupa. This prevents the pupa from curling the abdomen under the cephalothorax. Next, the individual squares of wax paper containing the pupae are placed on a glass slide and placed in the freezing compartment of a refrigerator at a temperature of minus ten degrees centrigrade. The pupae are allowed to freeze for a six- to eight-hour period. When the freezing process is first begun, the pupae should be checked periodically to see that they retain the desired position. At the end of the freezing period, the specimens are removed from the freezing compartment of the refrigerator and transferred to ten ml. serum bottles. The serum bottles are then connected to the vacuum drying attachment of a freeze-drying unit and dried for seventy-two hours. At the end of this period, the serum bottles are removed from the freeze-drying unit and the pupae may then be removed from the serum bottles and pinned on regular card points.

The author thanks Mr. W. C. Gilleland, Pres. Texas Biological Laboratories, Ft. Worth, Texas for use of freeze-drying equipment, and Cora Allen for technical assistance.

The author has preserved thirty pupae of *Culiseta inornata* (Williston) by this process. The specimens were placed on card points and stored in a regular Schmitt box. At this time the specimens are eight months old. They are in a good state of preservation and have an almost lifelike appearance. It has been observed that some of the specimens become slightly dark during the drying process. Specimens preserved by this process are excellent for study under the dissecting microscope. Adult structures can be seen clearly beneath the pupal skin. Caution should be exercised in handling the pupae during the preserving process and after they are pinned, since rough treatment will break off body hairs.

Meryman (1960), in a detailed study of the freeze-drying technique reports preserving in lifelike appearance, spiders, insects, salamanders, birds, toads, and small mammals.

Reference

MERYMAN, H. T. 1960. The preparation of biological museum specimens by freeze-drying. Curator, III/1.

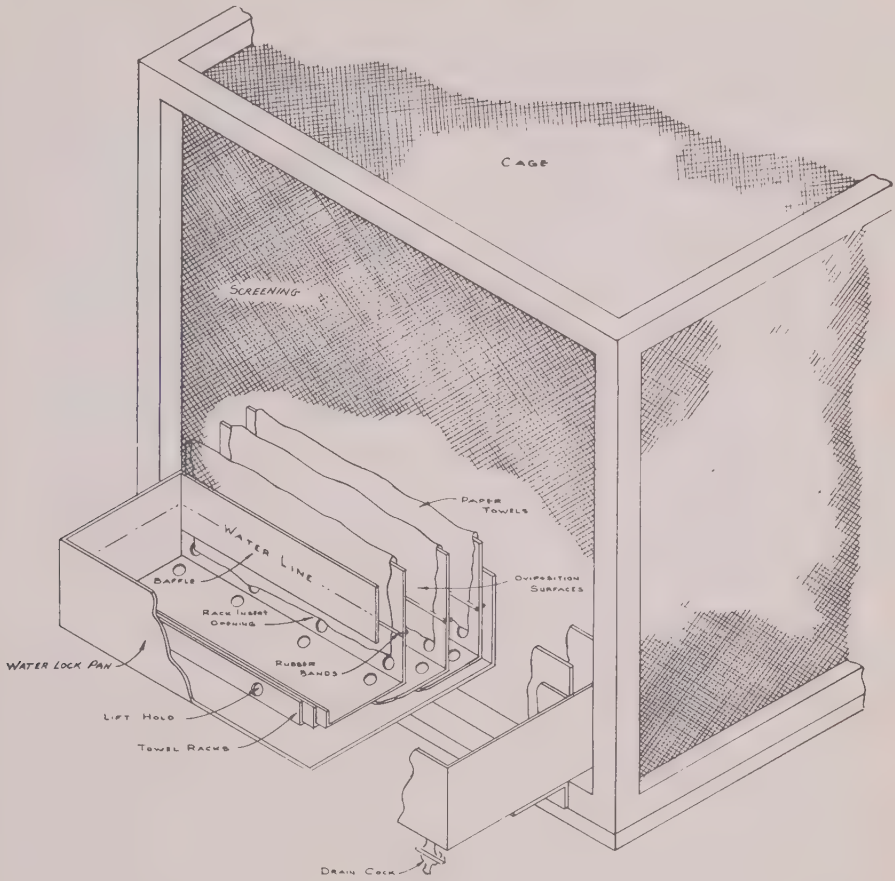
AN ESCAPE-PROOF MOSQUITO EGG HARVESTER

DANIEL J. REYNOLDS, Fort Detrick, Md.

In the general laboratory procedure for producing *Aedes* eggs, moistened paper towelling material placed in beakers or other containers is frequently utilized as an oviposition site. This ordinarily would require inserting an arm into the cage through a cloth sleeve. Such an operational technique creates a two-fold problem of permitting escape of mosquitoes and exposing the person to mosquito bites.

A waterlock device using a water barrier has been fabricated to circumvent these usual cage manipulation problems. This system permits an operator to introduce paper towelling into a cage for oviposition without escapes or exposure to mosquito bites.

A mosquito egg harvester device, illustrated in the diagram (Fig. 1) has been designed and tested. It has three parts. The first part is a stainless steel pan which extends into the cage and acts as a waterlock when filled; this pan may be fitted with a draincock for draining and cleaning. The second component is a sheet metal baffle, which is constructed as an integral part of one wall of a mosquito cage, extends down into the waterlock pan and penetrates the water surface. The baffle and water combination effectively seal the interior of the cage from the outside and the water surface of the pan is divided into interior and exterior portions. Entrance to the interior of the cage can be made only by passage through the waterlock, under the baffle and up



MOSQUITO EGG HARVESTER

through the interior water surface. The third component of the egg harvester device consists of a metal structure used to hold the moistened paper towelling for oviposition. This structure is a J-shaped metal plate, the width of which is dependent upon individual requirements or the availability of proper width paper towels. The structure consists of a horizontal plate with two vertical plates. The higher vertical plate inside the cage has the paper towelling attached to it.

The paper towelling for oviposition surfaces is held in place on the higher vertical plate of the metal structure with a rubber band. A set of three metal structures with attached towelling is nested together for insertion into a cage.

The racks are introduced into the cage interior by rotating them through the pan waterlock under the baffle. The risers with affixed moistened towelling are brought to an upright position inside the cage. After the racks are in this position, they are drawn apart so that one covers the inner pan wall and another the inner wall of the baffle. With the exception of these two surfaces, each additional plate with overlapping towelling provides two oviposition surfaces.

After oviposition on the continually moistened towelling, the metal vertical plates are slid together and rotated out of the pan. Any adult mosquitoes clinging to the towelling are wetted and usually adhere to the racks when rotated

through the waterlock. The towelling is inspected and the immobilized wetted adults are destroyed.

The egg papers may be left on the structure for conditioning or they can be removed and replaced with fresh paper towelling for additional oviposition.

With the harvester one can introduce paper towelling into a mosquito colony cage as an oviposition surface without the usual escape of adults or exposure to mosquito bites. The free water in the pan helps to humidify the cage. The oviposition surface is in constant contact with moisture.

ON THE DIFFERENT TYPES OF RESISTANCE

L. VARGAS, Bureau of Evaluation, Undersecretariat of Public Health, Mexico

At the Seventh Meeting of the World Health Organization Expert Committee on Insecticides the following definitions were made: "Resistance to insecticides is the development of an ability in a strain of insects to tolerate doses of toxicants which would prove lethal to the majority of individuals in a normal population of the same species. The term *behaviouristic resistance* describes the development of the ability to avoid a dose which would prove lethal."

This means that through selection there appeared an increase in the power to avoid irritants.

According to Busvine and Pal (1958), *physiological resistance,* which is specific to a particular type of poison, is inherited, apparently by normal Mendelian process, and in several cases through single genes.

The *vigor tolerance* of Hoskins and Gordon depends on non-specific defence mechanisms due to improved condition, greater weight. Many genes might be responsible for this condition. As improved vigor might be due solely to environmental effects, such as improved nutrition, it could be reversible.

Normal insects may show *protective behavior* and avoid certain stimulants. Through selection, they might show behavioristic resistance, and through selection in a suitable population might show physiological resistance. Referring to behavior a certain number of specimens, or a population, show either protective behavior or behavioristic resistance.

If we consider that under the heading of resistance there are four clearly defined entities, the theoretical combinations of them could lead to the finding, either in nature or in the laboratory, of seven types.

The literature mentions several instances of physiological resistance, vigor tolerance, protective behavior or behavioristic resistance as isolated entities but we are waiting for instances of their combinations.

Reference

BUSVINE, J. R. and PAL, R. 1958. Resistance of insects to insecticides. A note on terminology. Indian J. of Malariology 12(4):265–267.

Theoretical combinations of resistance entities

a.—Physiological resistance
b.—Vigor tolerance
c.—Protective behavior
d.—Behavioristic resistance

1.—		a	b	Physiological Resistance	+	Vigor tolerance [1]
2.—		a	c	Physiological Resistance	+	Protective Behavior [2]
3.—		a	d	Physiological Resistance	+	Behavioristic Resistance [1]
4.—		b	c	Vigor tolerance	+	Protective Behavior
5.—		b	d	Vigor tolerance	+	Behavioristic Resistance
6.— [3]		c	d	Protective Behavior	+	Behavioristic Resistance
7.—	a	b	c	Physiological Resistance	+ +	Vigor tolerance Protective Behavior
8.—	a	b	d	Physiological Resistance	+ +	Vigor tolerance Behavioristic Resistance
9.— [3]	a	c	d	Physiological Resistance	+ +	Protective Behavior Behavioristic Resistance
10.— [3]		b	c	d	Vigor tolerance	+ +	Protective Behavior Behavioristic Resistance
11.— [3]	a	b	c	d	Physiological Resistance	+ + +	Vigor tolerance Protective Behavior Behavioristic Resistance

[1] Suggested by Busvine and Pal (1938).
[2] Suggested by Busvine and Pal (1938) and considered of "considerable importance."
[3] By definition this combination does not exist.

The Volumes in a Horizontal Cylindrical Tank at Various Depths

Harold Farnsworth Gray

A manager of a mosquito abatement district recently came to me for the solution of a problem. Since it is one that may occur in other districts, I offer a solution for the benefit of other managers who may have a similar problem.

The problem is this—how can you determine the amount of liquid (oil, gasoline, liquid insecticide, etc.) in a horizontal cylindrical storage tank by measuring the depth of the liquid with a gauging stick? Sometimes a tank manufacturer will provide a table or a diagram which will indicate the volume for each inch of depth above the bottom, but sometimes second-hand tanks may be purchased, or obtained from military surplus for which no such table or diagram is available.

The basic problem is to find the area of a segment of a circle. There are several approximate formulae, for example $A = \frac{2CM}{3}$, where A is the area, C is the length of the chord, and M is the middle ordinate (or depth), as shown in Figure 1.

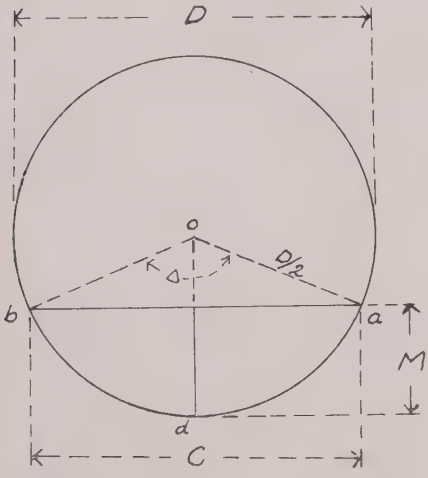


Fig. 1.—Diagram to assist in explaining steps in calculating volumes at different levels in tank.

However, the error will amount to about 3.5 percent at ¼ or ¾ depth, and it is necessary to compute the value of the chord C for various depths.

Exact formulae are available using radians as the angular measure, but trigonometric tables of angles in terms of radians are not usually available, and relatively few people are accustomed to this kind of circular measure.

A valid procedure for calculating the exact area of a segment of a circle is to compute the area of a sector (Fig. 1, oadb), compute the area of the triangle oab, and subtract the area of the triangle from the area of the sector. To do this it is necessary to compute the values of the middle ordinate M and of the chord C for various values of the central angle △, from zero degrees to 360 degrees.

The formulae for these two factors are $C = D \sin \frac{1}{2} \triangle$, and $M = D/2\ (1 - \cos \frac{1}{2} \triangle)$, where D is the inside diameter of the tank. The area of the sector is $A_1 = \frac{\triangle^\circ}{360^\circ}\ (0.7854\ D^2)$, and the area of the triangle is $A_2 = C/2(D/2 - M)$. The area of the segment is then A_1 minus A_2.

For any individual tank this may be a bit laborious and subject to possible arithmetical errors. But if we once compute the values of the area of the segment, with the corresponding middle ordinate, for each 20° (say) of the central angle △, using the value of one (1) for the diameter of the circle, we then can plot a curve of the area of the segment for any value of M, from zero to D, for any tank, by multiplying these tabular values by the tank diameter to get M (the depth), and by the square of the diameter to get the area. Then the area multiplied by the inside length of the tank will give the volume at the various depths (in cubic feet), and if this volume is multiplied by 7.48 the result is the volume in gallons.

The corresponding values of M and A, for a value of D equal to one (1), are set forth in the following table, for each 20° of the circle. The values were computed to the nearest four places, using a 20-inch slide rule, and are shown to the nearest three places.

TABLE 1.—Values of middle ordinate M and area A of a circular segment for a diameter D of 1

Middle ordinate M (depth)	Area of segment A
0.007	0.001
0.030	0.007
0.067	0.023
0.117	0.051
0.179	0.095
0.250	0.154
0.329	0.225
0.413	0.306
0.500	0.393
0.587	0.479
0.671	0.560
0.750	0.632
0.821	0.691
0.883	0.734
0.933	0.763
0.970	0.780
0.993	0.785
1.000	0.7854

After you have transformed the above values into feet and inches and into gallons, for a particular tank's diameter, they should be plotted on a rectangular coordinate chart, using feet and inches for the abscissas and gallons for the ordinates, and then drawing in the curve. The chart should be about 30 inches tall by about 20 inches wide. If you know an engineering draftsman perhaps he can be persuaded to draw the chart for you, and thus you could get a more accurate curve and a neater drawing. If desired, from this curve you can make up a table of volumes for each inch of depth.

The basic figures given are for a cylindrical tank with flat ends. If the tank has dished ends, it will be necessary to multiply the cross-sectional area of the tank by the varying lengths at the different depths. For example, if a tank which is 12 feet long has ends dished out 6 inches, the length at mid-depth will be 13 feet, and will be about 12 feet 6 inches long at about 30 percent and 70 percent of the depth. In this case it will be advisable to draw the curve in pencil as if it had flat ends, and then plot the volumes at 30 percent, 50 percent and 70 percent, and then redraw the final curve through these points and approximately parallel to the flat end curve.

Too great an attempt at mathematical accuracy is not justified, as a cylindrical tank lying on its side, whether in the ground or above ground, will be distorted slightly from a true circle by either its own weight or the varying weight of its contents if above ground, or by earth pressure if below ground.

DIELDRIN CEMENT BRIQUETTES IN CONTROLLING *Aedes aegypti* IN FIRE BARRELS

BURTON R. EVANS [1] and EDWARD J. FINK [2]

This study deals with testing the effectiveness of dieldrin cement briquettes for *Aedes aegypti* (Linn.) control in fire barrels under field conditions.

[1, 2] Entomologist and Biologist, respectively, U. S. Quarantine Station, New Orleans, Louisiana; Division of Foreign Quarantine, Public Health Service, U. S. Department of Health, Education, and Welfare.

Elliot (1955) found that briquettes of sand and cement mixed with 50 percent water wettable dieldrin controlled *aegypti* in water jars in Africa for up to a year.

The Communicable Disease Center, Public Health Service, in its report on "Public Health Pesticides" for 1960, suggests the use of dieldrin briquettes as a possible technique for controlling *aegypti* and *Culex quinquefasciatus* Say in fire barrels.

METHODS AND MATERIALS. Dieldrin briquettes were made according to Elliot's formula of sand and cement (5:1) mixed with 50 percent water wettable dieldrin (2:1). Five grams of briquette (16.6 percent dieldrin) were added for each one gallon of water (Anon. 1960), or 275 grams for a 55-gallon fire barrel.

Aegypti were breeding heavily in 18 fire barrels located in a cotton warehouse along the waterfront in New Orleans. Ten of these barrels were selected at random for treatment with briquettes; eight were untreated and used as controls. The barrels, except the controls, were treated on July 21, 1959, and inspected at intervals for 150 days. All of the barrels contained waste cotton and organic refuse.

When inspections were made for the *aegypti* larvae, an additional check of the residual effectiveness of the insecticide was made by taking a 50 ml. sample of water from each barrel. The water sample was taken to the laboratory and placed in a bowl. Ten *aegypti* larvae, from the untreated barrels at the warehouse, were added to each bowl of water. The percent mortality was recorded after 24 hours. Immobile larvae or those unable to surface were considered dead.

RESULTS. The results of the fire barrel inspections are as follows:

No live *aegypti* larvae were recovered from treated barrels after the first day. *Aegypti* larvae were recovered from untreated control barrels from July through December 7, 1959, after which the weather became very cold. Contrariwise, *quinquefasciatus* continued to breed in control and treated barrels. Fire barrels having a mixed population of *aegypti* and *quinquefasciatus* had a complete mortality of *aegypti* 24 hours after treatment, but there was no apparent effect upon *quinquefasciatus*.

Water samples were taken from each barrel at 30-day intervals to test for insecticide content in

TABLE 1.—Percent of fire barrels positive for *A. aegypti* larvae in days after treatment

Treatment	No. of fire barrels	Average percent of barrels positive by days								
		0	1	10	20	30	60	90	120	150
Dieldrin	10	100	0	0	0	0	0	0	0	0
Control	8	100	100	75	87	87	75	75	25	0

TABLE 2.—Percent mortality of 10 *A. aegypti* larvae after 24 hrs. in a 50 ml. sample from each barrel in days after treatment

Treatment	No. of fire barrels	Average percent mortality by days				
		30	60	90	120	150
Dieldrin	10	95	45	32	24	21
Control	8	10	11	0	3	1

the water. Toxicity in the water seemed to drop sharply after 2 months, with a more gradual decrease following this period. The high organic content of the water in the barrels may have been responsible for reducing the effectiveness of the briquettes.

Summary. All *Aedes aegypti* larvae in the fire barrels were dead 24 hours following treatment with dieldrin briquettes, and no *aegypti* were recovered from the treated barrels during the 150 day inspectional period. However, 2 months after treatment, the water from the treated barrels was no longer capable of giving a satisfactory mortality in the laboratory. Possibly the high organic content in the water reduced the effectiveness of the insecticide at the dosage used. The dieldrin briquettes were completely ineffective in controlling *Culex quinquefasciatus*.

References Cited

Anonymous. 1960. Public health pesticides. Communicable Disease Center. U. S. Public Health Service, Department of Health, Education, and Welfare. 11 pp.

Elliot, R. 1955. Larvicidal control of peridomestic mosquitoes. Roy. Soc. Trop. Med. and Hyg. Trans. 49(6):528–542.

LIST OF ADVERTISERS

	Page
American Cyanamid Co.	VIII
California Mosquito Control Assn.	XI
Concession Supply Co.	XI
Consolidated Industries	IX
Curtis Automotive Devices	XVI
Desplaines Valley Mosquito Abatement Dist.	383
Florida Anti-Mosquito Assn.	XV
Hausherr's Machine Works	XIII
H. D. Hudson Mfg. Co.	VI
Illinois Mosquito Control Assn.	375
New Jersey Mosquito Exterm. Assn.	XV
Richfield Oil Corp.	X
Schield Bantam Co.	II, III
Seeburg Corp.	XIV
Sherwin-Williams Co.	VII
D. B. Smith & Co.	X
Southern Mill Creek Products Co.	XII
Todd Shipyards Corp.	V
Utah Mosquito Abatement Assn.	367
Velsicol Chemical Corp.	IV
Virginia Mosquito Control Assn.	353
Wyco International	I

ASSOCIATION NEWS

A HISTORY OF THE AMERICAN MOSQUITO CONTROL ASSOCIATION *

FOREWORD

The American Mosquito Control Association, like many other technical and professional organizations, was founded because of the need for an association of all the various types of workers engaged in a particular specialized field. The major societies of physicians, engineers, and entomologists, for example, with their broad interests, are unable to represent adequately all areas of interest within their respective fields. In some fields of professional endeavor, several types of special skills have to be related for adequate performance. This has proved to be particularly true in the field of mosquito control, where the techniques of the physician, the entomologist, the engineer, the administrator and the legal counsel, plus the work of the public citizens who serve on the policy making boards, must be blended for successful operations.

The actual formation of such associations usually occurs some little time after the need is first felt. In some instances, action results from a crusading spirit; in others, as a means of defense against adverse conditions or pressures. All these influences seem to have been present in the formation of the American Mosquito Control Association. Its purposes and ideals are well expressed in the following statement, which appears on the back cover of its official publication, "Mosquito News":

"An association of mosquito workers, entomologists, medical personnel, engineers, public health officials, military officers and personnel, and laymen who are charged with, or interested in mosquito control and related work.

"A non-profit, technical, scientific and educational association, the purpose of which is to promote closer cooperation among those directly or indirectly concerned with, or interested in mosquito control and related work; to work for the highest standards of efficiency in such work; to encourage further research; to disseminate information about mosquitoes and their control; to work for understanding, recognition and cooperation from public officials and from the public; to encourage the enactment of legislation providing for a sound, well balanced program of mosquito control work suited to local conditions wherever needed; to meet fairly and understandingly, and thus disarm opposition to mosquito control work from any source; to protect wildlife in every possible way from avoidable harm, and to encourage the use of control measures calculated to bring about the best practicable degree of adjustment where diverse interests are involved; to work for the highest degree of understanding cooperation with related organizations, to the end that the best interests of all may be most fully served; and to publish *Mosquito News* as a journal of mosquito control work, in the furtherance of these objectives."

FORMATION OF THE ASSOCIATION

The American Mosquito Control Association and its predecessor society, the

* Prepared by the Historical Committee: R. D. Glasgow, T. G. Raley, Robert L. Vannote, Thomas D. Mulhern, Harold Farnsworth Gray, Chairman.

Eastern Association of Mosquito Control Workers, resulted from a need which was not met, and apparently could not be met, by then existing associations.

There were at that time a number of national professional and technical societies which were concerned with certain aspects of mosquito control. Among them were the entomological societies, such as the American Association of Economic Entomologists; the several medical groups, such as the National Malaria Society and the American Society of Tropical Medicine; and the American Society of Civil Engineers. But none of these were in a position to coordinate and lead all interested groups. There were also such governmental groups as the Bureau of Entomology and Plant Quarantine of the United States Department of Agriculture, and the United States Public Health Service. But neither of these organizations met the over-all problems. None included all the various types of personnel involved: entomologists, engineers, chemists, toxicologists, biologists, and the administrative and legal personnel.

There were also certain state associations of mosquito control workers, such as those in New Jersey, California, and Florida, which did excellent work in their own areas, but were not set up to fill a nationwide need.

The New Jersey Mosquito Extermination Association, organized in 1913, was the first effective local association of mosquito control workers. Its membership was limited to New Jersey agencies although guests attended its meetings from other areas. In 1922, Florida formed its own association and California formally organized in 1930. Other regions which have since organized associations are Utah, Virginia, Illinois, Texas, the Northeastern States, Northwestern States, Oregon, and Louisiana.

A premature attempt to form a national organization had been made in 1903. (1957. *Mosquito News* 17(1):52). On December 16 of that year at New York there was formed the "National Mosquito Extermination Society." The roster contained such well known names as L. O. Howard, E. P. Felt, John B. Smith, W. E. Britton, Vernon L. Kellogg, Herbert Osborn, D. W. Coquillett and H. C. Dyar. The Society held one other meeting at New York and Brooklyn on December 15 and 16, 1904, but there is no record that any further meetings were held.

The next attempt to form an organization of mosquito control workers which was more than intrastate in scope did not take place until the spring of 1935. At monthly meetings of the "Associated Executives of Mosquito Control Work in New Jersey" there were discussions of the need for an organization of mosquito control workers in the Middle Atlantic states. It appeared to be necessary to seek a compromise approach to the seemingly opposed interests of wildlife conservation and mosquito control. The problem had become acute, for charges of wholesale destruction of wildlife were being leveled at mosquito control agencies by some poorly informed individuals. Claims were being made that mosquito control operations were responsible for a pronounced decrease in migratory game bird life on the Atlantic Coast salt marshes, and that mosquito control operations should be curtailed or modified in ways which would have made them ineffective. It was imperative that this unjustified criticism be met fairly and scientifically.

Partly in order to do this, the Eastern Association of Mosquito Control Workers was organized at Trenton, New Jersey on June 26, 1935. Its membership at first was composed of executives of mosquito control projects from Massachusetts to Virginia, and various scientists, with some representation from Federal government bureaus. As time went on, persons from other areas joined this group until it had representation in a number of states, even as far west as California.

A second important influence in the formation of a regional association was the realization by the founders that advances in the knowledge of mosquito control were being made so rapidly that

some vehicle was necessary to promote the more rapid exchange of scientific knowledge. There was also an obvious need for frequent conferences and visits to progressive projects to study the advances being demonstrated.

The Eastern Association in due course began publication of a small journal named "Mosquito News." Through it, facts and opinion in relation to mosquito control could be published and accurate information about the ecology of coastal marshes and the relationship of mosquito control to aquatic wildlife could be put before the public. "Mosquito News" was established as a quarterly journal, the first issue appearing in March 1941. From 1935 until 1941 the members had been kept posted on matters of interest by mimeographed sheets distributed as occasion required.

The Eastern Association held a General Meeting annually, except in 1943 when wartime restrictions on travel were in effect. It also held business meetings when and as required, and upon occasion conducted extensive field trips (Appendix "B") for observation of mosquito control operations and for exchange of ideas on equipment and materials. In addition to the often perplexing and difficult problems arising from the actions of sometimes overenthusiastic groups within the conservation movements, there were difficult control problems arising in the 30's due to the depression, by 1940 from the preparedness program, and after 1941 from war requirements. Relatively little attention was given during this period to the problems of organization and administration.

During the war the membership of the Eastern Association increased, with new members widely scattered through the various states. A spontaneous demand arose for reorganization as a national group, and finally after much discussion and planning, on March 16, 1944, the American Mosquito Control Association was organized by dissolving the Eastern Association and transferring to the "American Mosquito Control Association" all of its assets including "Mosquito News."

For the first few years after the organization of the American Association, the annual meetings were held with the annual meetings of the New Jersey Mosquito Extermination Association at the same times and places. Many of the members of the American Association regularly attended the New Jersey Association meetings, and the advantages of an established group, meeting place, and procedure were obvious. The first meeting away from New Jersey was in 1947 at Philadelphia. The next year (1948) the American Association met jointly with the Florida Anti-Mosquito Association at Fort Pierce, Florida. A policy decision was reached that annual meetings were to be held in geographic rotation, with such state associations as were able to set up and carry out the necessary local arrangements.

In 1949, the Association held a joint meeting with the California Association. This and other meetings followed what has become a typical pattern: after the discussion sessions there was a trip to various points of interest to mosquito abatement workers. In this instance, the formal meeting was held at the University of California in Berkeley, followed by a caravan of over 600 miles through the Central Valley, with visits to numerous mosquito abatement districts, and with scenic side-trips to Yosemite Valley and Sequoia National Park, enlivened by a snow storm in "sunny" California; a second meeting at Los Angeles, with Hollywood entertainment, and finally, visits to districts in Southern California.

In 1950 the annual meeting was held at Virginia Beach with the Virginia Mosquito Control Association. It was preceded by the assembly of many members at Washington, D. C., with trips to the Naval Medical Research Center and the National Institutes of Health and a trip by car to Mount Vernon and other points of interest in Virginia. The meeting was followed by an inspection trip through parts of Virginia, Maryland, Delaware and New Jersey. Many of the delegates attended the immediately subsequent annual meeting of the New Jersey Association at Atlantic City.

In 1951 the American Association met at Chicago jointly with the then recently formed Illinois Association, and a short field trip was made to the Desplaines Valley and North Shore Mosquito Abatement Districts.

In 1952 the Association met jointly with the Utah Association at Salt Lake City, with several interesting field trips during and after the meeting, including a visit to the famous open pit copper mine at Bingham Canyon.

The 1953 annual meeting was held at Daytona Beach, Florida, with interesting trips before and after the meeting.

The Association returned to Atlantic City in 1954 for a joint meeting with the New Jersey group, but without an organized field trip.

In 1955 the American Association met again with the California Association at Los Angeles. This meeting was dedicated to Harold F. Gray upon his retirement from active service. In place of a field trip, there was substituted a fairly extensive demonstration of equipment.

In 1956 the annual meeting was held at Beaumont, Texas, with a trip to Galveston. To some extent, this meeting was held to stimulate interest in mosquito control in Texas, which is large not only in area but also large in mosquito problems.

The 1957 annual meeting was held at Miami Beach, Florida. The 1958 annual meeting was held at Washington, D. C., the 1959 annual meeting at Salt Lake City, Utah, and the 1960 annual meeting in Boston, Massachusetts.

Although the primary purpose of the annual meetings of the Association has been to give serious attention to the technical and administrative phases of mosquito control, they have also afforded an opportunity, often the only opportunity, for the members to become acquainted with each other, with public officials and with members of other societies and professions who have been our guests. These informal gatherings have been both pleasant and profitable for all concerned.

Constitution and Bylaws

The following is quoted from "Mosquito News" (1945–5(2):55): "The suitability of the original constitution (of the Eastern Association) was questioned at the organization meeting in 1944, and the Constitution Committee, composed of Dr. E. N. Cory, Mr. R. E. Dorer and Mr. R. L. Vannote, was directed to review it. After study of the particular needs of the association, as revealed during the first year of its existence as a national association the Constitution Committee prepared an entirely new document, which has been approved by the Executive Committee, and subsequently adopted by the general membership." The new constitution allowed for affiliation of sectional mosquito control groups and related organizations with the American Association. It appears in full, together with the ByLaws, in "Mosquito News" (1945. 5(2):56–58).

As originally organized in 1944 the American Mosquito Control Association had a relatively simple constitution and bylaws. As the business of the Association increased, and with it its revenues and the cost of publishing both "Mosquito News" and the special bulletins, a need appeared for a more stable and permanent type of organization with limited financial responsibility for the officers. Incorporation as a non-profit corporation was the logical solution and Dr. R. D. Glasgow, then Editor of "Mosquito News," suggested that a committee be appointed to consider the problem and propose a solution.

A committee on incorporation of the Association was appointed by President H. H. Stage in April 1947, the members being Dr. Glasgow, Chairman, Bailey B. Pepper, Harold F. Gray, Don M. Rees, and John A. Mulrennan. At the Ft. Pierce meeting in March, 1948, this committee recommended that the Executive Committee of the Association proceed to incorporate the association under the laws of the State of New Jersey, subject to approval by the general membership by letter ballot. On November 30, 1948, the American Mosquito Control Association

was incorporated as a non-profit corporation under the laws of New Jersey. The late M. M. Stallman of New Jersey gave valuable legal advice and assistance in the preparation and processing of the articles of incorporation and in the development of various portions of the several drafts of the bylaws. The articles of incorporation were published in "Mosquito News" (1948. 8(4):190–192). The original incorporators were R. E. Dorer, R. D. Glasgow, H. F. Gray, W. V. King, T. D. Mulhern, T. E. McNeel, H. D. Peters, D. M. Rees and L. W. Smith. This group then became the national officers of the corporation as an Interim Board pending the adoption of bylaws. The Articles of Incorporation now took the place of a Constitution. Upon receipt of the Articles of Incorporation the Executive Committee of the old Association acted to transfer all of its assets and liabilities to the new corporation. Following incorporation, Dr. Glasgow presented in an editorial a proposed program for the corporation, which outlined its purposes and aspirations, and has been a useful guide ever since. (1948. "Mosquito News" 8(4):193–196).

The Interim Board was required to prepare a set of bylaws for the corporation. This task was placed in the hands of a committee appointed on April 11, 1949, consisting of Dr. Glasgow, Chairman, B. B. Pepper, D. M. Rees, J. A. Mulrennan, E. E. Lynch and L. W. Smith.

This committee eventually reported its recommendations and the suggested bylaws were duly published (1950. "Mosquito News" 10(4):220–227.) There was considerable difference of opinion as to what should be the content of the bylaws. One original draft was quite lengthy and elaborate—another was quite brief and with little detail. Eventually the divergent views of the committee members were reconciled, and reasonable agreement was obtained.

The bylaws were unanimously adopted by vote of the membership of the Association at the Chicago meeting on March 8, 1951. On May 1, 1957 the bylaws were completely revised to their present state.

Membership and Publications

Mosquito News

Since its beginning, the American Association has grown greatly in stature and usefulness, and the number of members and subscribers to the official Journal, *Mosquito News,* has increased from less than 100 in 1944 to over 1600 in 1960. It has attracted members from 110 countries of the world, so that it is actually international in its scope and range of interest. The quality of the papers and discussions at its meetings, and of those published in "Mosquito News" has steadily improved and the range of interest has widened.

A particularly valuable feature of "Mosquito News" which is appreciated by mosquito control workers throughout the world, is the bibliography. This is compiled by Miss Helen Sollers of the Agricultural Research Service of the U. S. Department of Agriculture, formerly the Bureau of Entomology and Plant Quarantine. The references are world-wide in scope, and are grouped by categories for facility in use. Another useful feature is the section of "Reviews & Abstracts" of important articles and reports, arranged for or prepared by Mrs. Helen Louise Durkee.

An interesting and valuable activity of the Association has been the "Good Neighbor Club," initiated and for a long time conducted by Harry H. Stage, more recently by Dr. Ernestine Thurman. The plan was to help people in foreign countries who were interested in mosquito control but were handicapped by post-war difficulties and the distortion of monetary relationships. Persons and also organizations such as libraries in this category, were sent subscriptions to "Mosquito News." These subscriptions have been supported by voluntary contributions from American members and have not only helped our foreign co-workers and contributed to international good will, but have increased the world-wide recognition of the Association, and have helped defray in part the production cost of "Mosquito News."

Special Bulletins

An important project of the American Association has been the preparation and publication of special bulletins dealing with procedures and techniques in mosquito control. Three bulletins have been published and a fourth is in preparation. The first, published in 1948, was entitled "The Use of Aircraft in the Control of Mosquitoes." It included 68 pages and was well illustrated. The background of this bulletin was interesting. In October, 1947, President Harry H. Stage requested the membership to meet at Ashville, North Carolina to write the first draft of the proposed bulletin. About 50 persons responded and accomplished the task in three days, subcommittees writing the various chapters. The sections were then submitted to Dr. Paul F. Russell of the Rockefeller Foundation for assembling and coordination, and the final report was then edited by Dr. R. D. Glasgow and Dr. D. L. Collins, Editor and Associate Editor, respectively, of "Mosquito News." The Association is greatly indebted to H. W. Van Hovenberg, who assisted by allocating a small reserve left from a malaria control fund, originally donated by Edwin Gould, Chairman of the Board of Directors of the St. Louis Southwestern Railroad. From this fund, Mr. Van Hovenberg loaned $400 to assist in financing the printing of the bulletin, and when the loan was repaid, made a grant of $500 to assist in publishing future bulletins. (1948. *Mosquito News* 8(3):122). Mr. Van Hovenberg later made substantial contributions to the "Good Neighbor" Club from the Gould Fund, in the amount of $170. Harry H. Stage and Ralph W. Van Derwerker guaranteed to underwrite the balance of the costs from their own personal funds, but the bulletin sold well and ultimately repaid its entire cost.

The second special bulletin, published in March, 1952, was entitled "Ground Equipment and Insecticides for Mosquito Control." It contained 118 pages. Like the first, it was well illustrated with photographs and contained many tables of useful data.

The members of the committee which produced this bulletin were: Robert L. Vannote, Chairman; William E. Bickley, H. D. Peters, R. L. Armstrong, J. L. Clarke, T. G. Raley, L. W. Smith, H. H. Stage and R. E. Dorer. Dr. E. F. Knipling served as Editor. This bulletin also sold well, and both Bulletins No. 1 and No. 2 eventually produced a small profit for the Association.

The third bulletin was entitled "Mosquito Culture Techniques" and was written by Mrs. Helen Louise Trembley Durkee, to whom the American Association is greatly indebted for a long period of devoted service in several capacities. It contains 73 pages and was published in 1955. It, also, has been highly acclaimed. The production problems were solved by Commander John M. Hirst, MSC, USN. The editor was Dr. Donald L. Collins, and the fly leaf of the bulletin contains a full page of credits to others who assisted in its preparation. It has sold fairly well, and in spite of its somewhat limited application, it has entirely paid for the cost of production. It is felt that from time to time there will be bulletins which the Association should publish, but on which it may not be possible to recover the entire cost through sales.

A special publication, somewhat different in composition from the regular bulletin series, but nevertheless an important contribution to the literature on mosquito control, was published under the title, "The Use of Fogs and Mists for Adult Mosquito Control. Proceedings and Papers of the Toledo Seminar of the American Mosquito Control Association." The title is self-explanatory, and the publication was printed following the seminar held at Toledo, Ohio, on September 29 through October 1, 1954. The proceedings were recorded and edited by the Toledo Area Sanitary District, and the 65 page booklet was published through the courtesy of Willys Motors, Inc.

At the present time there is in preparation a fourth bulletin dealing with the organization and functions of mosquito control agencies. A large committee headed

by CDR John M. Hirst has assembled the material for this bulletin, which is to be edited for publication by Harold F. Gray.

Publication of Proceedings

Prior to 1949 the more important items of the annual business meetings were reported in "Mosquito News" and some of the papers and committee reports presented were published therein.

For the 1949 meeting, held jointly with the annual meeting of the California Mosquito Control Association, the entire proceedings of both associations were published by the California Association. The Proceedings of the 1950 meeting, which was held at Virginia Beach, were reproduced in a limited special edition, financed by contributions from the Virginia Association and individual members of AMCA.

There has been no "official" policy as to the publication of the papers and proceedings presented at the annual meetings. In general, where the local association regularly publishes its own proceedings in printed form (New Jersey and California) the proceedings and papers are included therein, and enough extra copies are printed for distribution to the members of the American Association. With other meetings, the practice has been to publish in "Mosquito News" with the assistance of a financial contribution from the local or host association. Thus far, beginning in 1951, host associations which have contributed sums up to $1,500.00 each have been the Associations or groups in Illinois, Utah, Florida, Texas; the Southeastern Region, and the Northeastern Association.

PERSONALITIES

Dr. Thomas J. Headlee, Professor of Entomology and State Entomologist of New Jersey, a leader in early mosquito control activities and organization, in the years preceding the formation of the AMCA took every possible opportunity to foster exchange of information, cooperation, and association of mosquito workers. His advice guided the founders of the Eastern Association of Mosquito Control Workers and he gave valued counsel when the question of establishing a publication (he called it a "house organ") arose. When the proposal to nationalize the Eastern Association was made, his sage advice to its officers was to make it such a good organization that mosquito workers everywhere would want to become members and then nationalization would result from outside demands! And that did come to pass. He was responsible for the training of many mosquito workers, and was a constant source of inspiration to them.

Also from the beginning of the predecessor association, the Eastern, and all through the history of the American Association, Dr. Robert D. Glasgow has been a source of guidance and inspiration. Ever willing to labor indefatigably on any frustrating organizational problem, ever ready to consult with great patience in seeking a democratic solution of policy problems amid a welter of strongly contrasting ideas and opinions among the membership, and contributing always of his unexcelled editorial talents to make "Mosquito News" a journal unsurpassed in its field, his contributions to the association have been great indeed.

Another figure of world-wide influence in Medical Entomology, who has contributed much "over and above the call of duty" to the Association has been Dr. F. C. Bishopp.

Many other Association members have achieved national and international prominence, not only in mosquito work, but in other fields as well. Their names include Harold F. Gray; W. B. Herms and Robert Matheson, authors of standard texts on mosquitoes and their control; H. H. Stage, E. N. Cory, W. H. W. Komp, Louis A. Stearns, Paul Russell, H. W. Van Hovenberg, L. O. Howard, L. L. Williams, J. A. LePrince, Col. Stanley J. Carpenter, C. C. Adams, W. V. King, Fred L. Soper, and others.

Among contemporary active mosquito control workers the list of those who have aided the growth and development of the Association is just too great to attempt to list the individuals by name. But to all who have contributed, the entire association is indebted.

Through the years the Association has elected to Honorary Membership the following men who have been outstanding in the field of mosquito control:

Thomas J. Headlee,* New Brunswick, New Jersey, 1944; William B. Herms,* Berkeley, California, 1944; J. A. LePrince,* Memphis Tennessee, 1944; L. L. Williams, Jr., Washington, D. C., 1944; Willard V. King, Fort Lauderdale, Florida, 1948; Robert D. Glasgow, Albany, New York, 1948; Lewis W. Hackett, Berkeley, California, 1951; Robert Matheson,* Ithaca, New York, 1951; Harold F. Gray, Oroville, California, 1955; Louis A. Stearns,* Newark, Delaware, 1958.

Previously, the Eastern Association, in 1937 and 1940, had elected to Honorary Membership L. O. Howard* and C. C. Adams.*

Conclusion and Recapitulation

It is now 60 years since the first serious attempts at mosquito control were begun (Watson in Malaya, Gorgas and LePrince in Havana). At first the work was regarded by many people with scorn, amusement, contempt, and even hostility. Gradually the value of this work, first in the prevention of disease, then for human comfort, and finally for community economic benefit, has become recognized. Today scientists and professional men who formerly would have disdained to be associated with the work have become enthusiastic and devoted supporters of and contributors to the program, and the general public has accepted it to the extent not only of substantial tax support but also of strong community approval.

Not only have various professional societies contributed much to the work through scientific research and publication, but organizations of the practical field workers have been established to improve operations. At first these were local (for example, the New Jersey association). Ultimately the need for a national association was realized, and was effected through the organization of the American Mosquito Control Association, which has drawn to itself not only the administrators and field personnel, but also the scientific and professional groups who are an integral part of successful control measures. Now the American Association has in fact become international in scope and in membership. It has become acknowledged as an organization of real merit, which serves the public interest on a high level of technical and professional excellence, with sincere dedication to the welfare of mankind. Its past record is commendable and worthy of respect. Its future is bright with promise.

Historical Committee

Robert D. Glasgow, T. G. Raley, Robert L. Vannote, Thomas D. Mulhern, Harold Farnsworth Gray, Chairman.

Appendix A

1. Principal Meetings and Officers of The Eastern Association of Mosquito Control Workers (1935–1943).

First Meeting, June 26, 1935, Trenton, N. J. **P, T. J. Headlee; VP, R. D. Glasgow; ST, T. D. Mulhern.

Second Meeting, October 26, 1936, Newark, Del. P, T. J. Headlee; VP, R. D. Glasgow; ST, T. D. Mulhern.

Third Meeting, August 11, 1937, Providence, R. I. P, T. J. Headlee; VP, W. S. Corkran; ST, T. D. Mulhern.

Fourth Meeting, October 20–21, 1938, New Brunswick, N. J. P, T. J. Headlee; VP, W. S. Corkran; ST, T. D. Mulhern.

Fifth Meeting, August 25, 1939, Bayshore, N. Y. P, T. J. Headlee; VP, W. S. Corkran; ST, T. D. Mulhern.

Sixth Meeting, November 6, 1940, New Brunswick, N. J. P, L. A. Stearns; VP, R. C. Botsford; 2VP, R. L. Vannote; ST, T. D. Mulhern.

* Deceased.

** P—President.
VP—Vice President.
2VP—Second Vice President.
ST—Secretary-Treasurer.

Seventh Meeting, November 19, 1941, New Brunswick, N. J. P, L. A. Stearns; VP, R. C. Botsford; 2VP, R. L. Vannote; ST, T. D. Mulhern.

Eighth Meeting, November 6, 1942, New Brunswick, N. J. P, R. C. Botsford; VP, R. L. Vannote; 2VP, R. D. Glasgow; ST, T. D. Mulhern.

1943. No General Meeting held because of travel limitations due to war. 1942 officers continued through 1943.

Ninth Meeting, March 16, 1944, Atlantic City, N. J. At this meeting the Eastern Association was dissolved and became the American Association, with the following officers: P, R. L. Vannote; VP, R. D. Glasgow; 2VP, P. W. Ruth; ST, T. D. Mulhern.

2. Principal Meetings and Officers of the American Mosquito Control Association (1944–1960)

First Meeting, March 29, 1945, Atlantic City, N. J. P, P. W. Ruth; VP, R. D. Glasgow; 2VP, H. H. Stage; ST, T. D. Mulhern. Executive Committee: Above named and R. L. Vannote, H. L. Fellton, L. A. Stearns.

Second Meeting, April 4, 1946, Atlantic City, N. J. P, H. H. Stage; VP, R. D. Glasgow; 2VP, H. D. Peters; ST, T. D. Mulhern. Executive Committee: Above named and P. W. Ruth, L. A. Stearns, G. S. Comstock.

Third Meeting, April 5, 1947, Philadelphia, Pa. P, H. D. Peters; VP, H. F. Gray; 2 VP, W. V. King; ST, T. D. Mulhern. Executive Committee: Above named and H. H. Stage, R. D. Glasgow, T. E. McNeel, D. M. Rees.

Fourth Meeting, March 28–31, 1948. Ft. Pierce, Florida. Interim Board: Chair, H. D. Peters; ST, T. D. Mulhern; R. E. Dorer, R. D. Glasgow, W. V. King, T. E. McNeel, H. F. Gray, D. M. Rees, L. W. Smith, H. H. Stage.

Fifth Meeting, February 7–9, 1949, Berkeley, California. Interim Board: Chair., H. F. Gray; ST, T. D. Mulhern; R. E. Dorer, R. D. Glasgow, W. V. King, T. E. McNeel, H. D. Peters, D. M. Rees, L. W. Smith, H. H. Stage.

Sixth Meeting, February 23–24, 1950, Virginia Beach, Virginia. Interim Board: Chair., L. W. Smith, D. M. Rees, T. D. Mulhern, R. E. Dorer, H. F. Gray, H. D. Peters, R. D. Glasgow, W. V. King, T. E. McNeel, H. H. Stage.

Seventh Meeting, March 6–8, 1951, Chicago, Illinois. Board of Directors and Officers. P, D. M. Rees; VP, C. R. Twinn; ExS, T. D. Mulhern*; T, R. E. Dorer; L. W. Smith.

Eighth Meeting, March 24–27, 1952, Salt Lake City, Utah. Board of Directors and Officers. P, C. R. Twinn; VP, F. C. Bishopp; ExS, T. G. Raley; T, R. E. Dorer; D. M. Rees, L. W. Smith.

Ninth Meeting, April 12–17, 1953, Daytona Beach, Florida. Board of Directors and Officers. P, F. C. Bishopp; VP, R. E. Dorer; ExS, T. G. Raley; T, L. W. Smith; C. R. Twinn, D. M. Rees.

Tenth Meeting, March 8, 1954, Atlantic City, N. J. Board of Directors and Officers. P, R. E. Dorer; PE, R. F. Peters*; VP, F. H. Stutz; ExS, T. G. Raley; T, L. W. Smith; F. C. Bishopp.

Eleventh Meeting, January 23–27, 1955, Los Angeles, California. Board of Directors and Officers. P, R. F. Peters; PE, F. H. Stutz; VP, A. W. Lindquist; ExS, T. G. Raley; T, L. W. Smith; R. E. Dorer, F. C. Bishopp.

Twelfth Meeting, February 5–7, 1956, Beaumont, Texas. Board of Directors and Officers. P, F. H. Stutz; PE, A. W. Lindquist; VP, J. M. Hirst; ExS, T. G. Raley; T, L. W. Smith; R. F. Peters, R. E. Dorer.

Thirteenth Meeting, April 28–May 2, 1957, Miami Beach, Florida. Board of Directors and Officers. P, A. W. Lindquist; P.E., J. M. Hirst; VP, A. D. Hess; ExS, T. G. Raley; T, L. W. Smith; F. H. Stutz, R. F. Peters.

Fourteenth Meeting, Feb. 23–26, 1958, Washington, D. C. Board of Directors and Officers. P, J. M. Hirst; P.E., A. D. Hess; VP, D. M. Jobbins; ExS, T. G. Raley; T, L. W. Smith; A. W. Lindquist, F. H. Stutz, A. F. Geib.

Fifteenth Meeting, April 12–15, 1959, Salt Lake City, Utah. Board of Directors and Officers. P, A. D. Hess; P.E., D. M. Jobbins; VP, W. E. Bickley; ExS, T. G. Raley; T, L. W. Smith; J. M. Hirst, A. W. Lindquist,* RS, A. F. Geib.

Sixteenth Meeting, March 27–30, 1960, Boston, Mass. Board of Directors and Officers. P, D. M. Jobbins; PE, W. E. Bickley; VP, A. F. Geib; A. H. Hess; John M. Hirst; ExS, T. G. Raley; T, L. W. Smith,* RS, E. Thurman.

3. Regional Directors.

1951, 1952. D. MacCreary, D. M. Jobbins, F. H. Stutz, J. L. Clarke, A. F. Geib, A. W. Lindquist, H. W. VanHovenberg, O. W. Young, A. Gabaldon, A. S. West, H. H. Stage, N.A.*

1953. G. E. Washburn replaced A. F. Geib, and A. W. A. Brown replaced A. S. West.

1954. Changes as follows: S. Minnich for F. H. Stutz; O. McFeely for **J. L. Clarke; C. M.

---

* ExS—Executive Secretary.
T—Treasurer.
PE—President Elect.
RS—Recording Secretary.
N. A.—National Advisor
** Mr. Clarke died shortly after election, and almost his entire term was served by Franklin Wray.

Gjullin for A. W. Lindquist; C. A. Nau for H. W. VanHovenberg; D. M. Rees for O. W. Young; L. Vargas for A. Gabaldon; R. L. Vannote for H. H. Stage, N.A.

1955. Changes as follows: C. F. Scheel for O. McFeely.

1956. Changes as follows: D. W. Micks for C. A. Nau; A. D. Hess for D. M. Rees; B. Hocking for A. W. A. Brown; H. P. S. Gillette for L. Vargas.

1957. Changes as follows: W. E. Bickley for D. MacCreary; C. D. Grant for G. E. Washburn.

1958. Changes as follows: V. Conant for D. M. Jobbins; J. A. Mulrennan for V. S. Minnich; L. S. Miller for C. M. Gjullin; J. E. Graham for D. M. Rees; L. Vargas for H. P. S. Gillette.

1959. Changes as follows: R. W. Bunn for W. E. Bickley; O. P. Breland for D. W. Micks.

1960. Changes as follows: C. M. Gjullin for L. S. Miller.

4. Staffs, Boards and Committees of *Mosquito News*

A volume of *Mosquito News* comprises 4 issues, namely, March, June, September and December, numbered 1, 2, 3 and 4 of each volume. The personnel listed here were those listed in their respective capacities in the No. 4 issue of each volume, since the No. 1 issues were sometimes prepared before the changes resulting from an annual meeting could be included.

Vol. 1. (1940) L. W. Smith, Ed.; R. L. Vannote; R. J. VanDerwerker.

Vol. 2. R. J. VanDerwerker, Ed.; J. T. Hart, Jr.; C. T. Williamson.

Vol. 3. J. T. Hart, Jr., Ed.; C. T. Williamson; H. H. Stage; R. J. VanDerwerker.

Vol. 4. Editorial Board: R. D. Glasgow, Ed.; C. T. Williamson, Bus. Mgr.; T. D. Mulhern, Sec.-Treas. of Association.

Vol. 5. Editorial Board: same as for Vol. 4. Publications Committee: Edit. Board as above, with R. L. Vannote, R. Matheson and H. L. Fellton.

Vol. 6. Editorial Board: R. D. Glasgow, Editor; D. L. Collins, Helen Louise Trembley and H. H. Stage, Associate Editors; C. T. Williamson, Bus. Mgr.; T. D. Mulhern. Publications Committee: R. D. Glasgow; C. T. Williamson; T. D. Mulhern; H. H. Stage; R. Matheson; J. T. Hart, Jr.

Vol. 7. Same as Vol. 6.

Vol. 8. Same as Vol. 7 except for replacement of Stage, Matheson and Hart by H. D. Peters, A. D. Hess and B. V. Travis, on Publications Committee.

Vol. 9. D. L. Collins, Editor; R. D. Glasgow, Consulting Editor; Margaret G. Slater, Editorial Assistant; H. H. Stage, Helen Louise Trembley and R. F. Peters, Associate Editors; R. L. Vannote, Advertising Manager; C. T. Williamson, Business Manager; T. D. Mulhern, Secy.-Treas. of Association. Publications Committee same as for Vol. 8.

Vol. 10. Same as Vol. 9, with W. E. Bickley, Associate Editor.

Vol. 11. Editorial Staff, same as Vol. 10. R. L. Vannote, Advertising Manager; T. D. Mulhern, Exec. Secy.; R. Dorer, Treas. Publications Committee: H. F. Gray, B. I. Gerry, W. B. Owen, F. C. Bishopp, B. B. Pepper.

Vol. 12. Staff and Committee substantially same as for Vol. 11, but with addition of E. J. Hansens and B. V. Travis as Associate Editors and with T. G. Raley, Executive Secretary and R. E. Dorer, Treasurer.

Vol. 13. Associate Editors as follows: Helen Sollers, Helen Louise Trembley, A. W. Morrill and B. V. Travis. Other changes: W. E. Bickley, Advertising Manager; L. W. Smith, Treasurer; R. F. Peters, Chairman of Publications Committee.

Vol. 14. Same as for Vol. 13

Vol. 15. Editorial Staff same as for Vol. 14. C. R. Twinn, Chairman of Publications Committee; F. P. Creadon, Advertising Manager; William H. Thom, Assistant Treasurer.

Vol. 16. Same as for Vol. 15.

Vol. 17. Same as for Vol. 16, with addition of W. C. McDuffie as Associate Editor.

Vol. 18. Same as for Vol. 17.

Vol. 19. Same as for Vol. 18.

Vol. 20. Same as for Vol. 19.

APPENDIX B

Inspection Tours Held Under the Auspices of the Eastern Association of Mosquito Control Workers, 1935 to 1943, and the American Mosquito Control Association, 1944 and after.

(Some of the tours are reported in greater detail in other publications, and reference is made to these reports, using the following code: NJMEA Proc.—New Jersey Mosquito Extermination Association Proceedings. MN—Mosquito News. Each tour included many items in addition to those referred to).

1. 1936, Oct. 20–21. Coastal areas of Delaware, and Delaware Co., Penna. Salt marsh mosquito problems and work of CCC Camps in Delaware, and diked marshes and industrial mosquito problems in Penna. (1938–NJMEA–25 Proc:58).
2. 1937, Aug. 10–12. Massachusetts, Rhode Island, Connecticut. Salt marsh mosquito control problems, *Mansonia perturbans* and other fresh water mosquito problems, and community mosquito control. (1938–NJMEA–25 Proc:58).
3. 1938, Jan. 22–Feb. 15. Canal Zone, Republic of Panama, and Cuba. Malaria and yellow

fever control programs in Panama, research of the Gorgas Memorial Laboratory in jungle villages, and brief visit to the malaria control program near Havana, including the work of the Rockefeller Foundation. (1938–NJMEA–25 Proc:38–61).

4. ———. Oct. 20–21. New Jersey. Open and diked salt marsh and fresh water mosquito problems, equipment, and methods, in northern, central, and southern portions of the State. (1939–NJMEA–26 Proc:117).
5. 1939, Jan. 16–27. Georgia and Florida. Brief visit to Henry Rose Carter Laboratory (USPHS) at Savannah. Extensive tour of mosquito control projects about Jacksonville, Daytona, Ft. Pierce, Dade and Broward Counties, other east coast locations, the Florida Keys, Sarasota, Ft. Myers, Tampa, and St. Petersburg. USDA Research projects at Orlando and New Smyrna. (1939–NJMEA–26 Proc:118).
6. ———. Aug. 15–16, New York. Observe salt marsh mosquito control operations in Nassau and Suffolk Counties, also equipment, facilities, and some fresh water operations. Study plans for mosquito control at the New York World's Fair, at Flushing. (1940–NJMEA–27 Proc: 95).
7. ———. Oct. 26–27, New Jersey. Hudson, Bergen, Essex, Passaic, Morris, Middlesex, and Union Counties. A wide range of activities and problems, including open and diked salt marshes, industrial and residential areas, flood water areas, also equipment and operational facilities. (1940–NJMEA–27 Proc:97).
8. 1940, Feb. 15–21. Virginia, North Carolina. Study salt marsh and fresh water swamp mosquito problems, including those of the Dismal Swamp. Observe control operations of local agencies, and federal work relief agencies. (1940–NJMEA–27 Proc:98).
9. ———. June 26–27. Connecticut. Observe federal work relief projects in coastal areas, including a massive tide gate structure of new and permanent design. (1941–NJMEA–28 Proc:156).
10. ———. July 24–25. Delaware. Inspect work of CCC camps on salt marsh mosquito control. Visit research projects of the University of Delaware. (1941–NJMEA–28 Proc:156).
11. ———. Aug. 28, New York. Observe mosquito control techniques being practiced at the New York World's Fair, at Flushing. (1941–NJMEA–28 Proc:156).
12. 1941, July 29. New Jersey. Study the performance of hydraulic dredge in improving the channel of the Passaic River.
13. ———. Aug. 28. Delaware. Study problems of *An. quadrimaculatus* control in swamps near Fort Dupont, and observe concentration of adults in subterranean vaults at historic Fort Delaware on Pea Patch Island.
14. ———. Sept. 22–26. Alabama, Tennessee, Mississippi. Observe new techniques of malaria control on impounded waters, developed by the TVA. Visit USPHS office in Memphis, and the historic malaria control projects about that city. Attend meeting of the Howard-Krauss Society at South Side High School, Memphis, which was organized for malaria study by Mr. J. A. LePrince. (1942–NJMEA–29 Proc:113).
15. 1942, June 19. Virginia. Observe mosquito control operations about the U. S. Naval Air Station at Norfolk, and work on the City-County control program.
16. ———. Nov. 6. New Jersey. Observe the operation of dikes, tide gates, pumps, and excavation machines in the northeastern counties of the State.
17. 1944, Oct. 31-Nov. 1. Pennsylvania, New Jersey. Review accomplishments in Delaware County, Penn. and in Gloucester, Cape May, and Atlantic Counties in New Jersey. (1944–MN–4(4):120).
18. 1945, Mar. 29. New Jersey. Inspect circulatory ditching system and special salt marsh ditch cleaning machines in Atlantic County. (1945–MN–5(2):55).
19. ———. Nov. 20–21. Washington, D. C. area. Field visits to mosquito control projects in the District, and visits to the offices and laboratories of the USDA in Washington and Beltsville, and to the National Institutes of Health, the National Naval Medical Center, and the Army Medical Center. (1946–MN–6(1):34).
20. 1947, May 8–9. Illinois. Desplaines Valley Mosquito Abatement District, record keeping procedures, drainage equipment, 5 special off-the-road motorized spray and fog units, biological control in wildlife "oasis," and control of flies by DDT. (1947–MN–7(1):35) (1947–Desplaines Valley M.A.D.-Ann. Rept.: 14).
21. 1948, March 29, April 7. Florida. Visits to coastal area projects before and after Annual Meeting at Ft. Pierce. (1948–MN–8(2):77).
22. 1949, Feb. 10–15. California. Motorcade through San Francisco Bay Area, Sacramento Valley, San Joaquin Valley, Yosemite and Sequoia National Parks, Los Angeles and Southern California areas. Visits to various mosquito control agencies. (1948–MN–8(4): 175).
23. 1950, Feb. 21. Washington, D. C. area. Visits to USDA Offices and Laboratories, National Institutes of Health, and National Naval Medical Center. (1949–MN–9(4):181).
24. ———. Feb. 25–27. Virginia, Maryland, Delaware, New Jersey. Motorcades by individual autos, over various routes. Hampton Roads, Williamsburg, Va., through Maryland and Delaware, Cape May and Atlantic Counties in New Jersey, with some delegates visiting northern New Jersey and New York, following N. J. Mosquito Extermination Association Meetings, at Atlantic City. (1949–MN–9(3):120. 9(4):181) (1950–MN–10(2):99).
25. ———. July 11–15. Massachusetts, Rhode Island, Connecticut, Vermont. Inspect salt

marsh and fresh water mosquito control projects of various local programs. (1950–MN–10(3):155).

26. 1951, March 7. Illinois. Inspections of mosquito control operations of The Desplaines Valley, North Shore, Lake Forest, and Highland Park Mosquito Abatement Districts. See equipment and headquarters facilities. (1950–MN–10(4):217).
27. 1952, March 26. Utah. Tour of mosquito abatement problems and operations of several local agencies about Great Salt Lake. (1951–MN–11(4):224).
28. ———. July 30–31. Canada. Visit the Science Service, Canada Department of Agriculture, and the Ottawa Federal District Commission. See research program at the Dominion Experimental Farm, and observe demonstrations of fogging and spraying. Observe flood water mosquito producing areas. See new developments in protective clothing for wear in mosquito infested areas. (1952–MN–12(3):217).
29. 1953, April 12–18. Georgia and Florida. Inspections of various mosquito problem areas and control programs before and after Annual Meeting at Daytona Beach. Visit Silver Springs, Bok Tower, Lake Okeechobee, USDA Laboratory at Orlando, and USPHS Laboratory at Savannah, Ga. (1952–MN–12(3):219) (1952–MN–12(4):259).
30. 1954, March 13–14. New Jersey. See research facilities and program of the Department of Entomology, Rutgers University, and visit mosquito extermination commissions in northeastern part of State. (1954–MN–14(2):89).
31. 1954, Sept. 29–30. Ohio. Seminar on fogs and units for mosquito control. Host, Toledo Area Sanitary District. (1954–MN–14(2):111).
32. 1955, Jan. 28–30. California. Visit Mosquito Abatement Districts about Los Angeles. Individual motor trips to Mojave Desert, The San Joaquin Valley, Sacramento Valley, and through the coastal area to the San Francisco Bay area. (1954–MN–14(4):219) (1955–MN–15(1):49).
33. 1956, Feb. 8, Texas. Field inspection of salt marsh mosquito problems, Beaumont to Galveston. (1955–MN–15(4):237).
34. 1957, Apr. 26–28 and May 2–4. Florida. Before and after annual meeting at Miami Beach. Auto trips to Entomological Center, Florida State Board of Health at Vero Beach, and USDA Laboratory at Orlando. Visits to various local mosquito abatement programs and to Florida Keys. Witness equipment demonstration. (1956–MN–16(4):309 (1957–MN–17(1):50).
35. 1958, Feb. 27–28. Washington, D. C. area. Tour of scientific institutions, including the U. S. National Museum, the USDA Laboratories and offices at Beltsville, the Army Medical Center, and the National Institutes of Health. (1957–MN–17(4):319).
36. 1959, April 1–2. Washington, D. C. Symposium on Mosquito Control and Fish and Wildlife Management.
37. 1959, April 14–15. Utah. Witness demonstration of field equipment. Aerial flights over Great Salt Lake and vicinity. (1958–MN–18(3):259).

AMERICAN AND CALIFORNIA MOSQUITO CONTROL ASSOCIATIONS

DISNEYLAND, CALIFORNIA

January 30, through February 2, 1961

The California Mosquito Control Association welcomes all mosquito workers to Disneyland, January 30 through February 2 and beyond. A comprehensive program of what's new, interesting, and pertinent is included in this issue and speaks for itself. Plan to attend both for knowledge and fun. You will note that concurrent sessions have been arranged for submitted papers, practical field operations, and Trustee sessions where policies of mutual interest will be discussed.

SPECIAL TOURS FOR EARLY ARRIVALS

Since the Board of Directors of the AMCA will be meeting all day Monday, and Disneyland Park is closed Monday and Tuesday during the winter season, an outstanding selection of sightseeing tours has been arranged for early arrivers, which will include the wives and families of the Officers and Directors.

COMBINATION HOLLYWOOD TOUR—MONDAY, JANUARY 30, 1961

If twenty-five people (25) make reservations by Sunday night, January 29, with the Local Arrangements Committee, a Tanner Sightseeing Bus will be chartered for this special tour on Monday. The sightseeing will include the Hollywood Bowl, Grauman's Chinese Theater, Brown Derby, Farmer's Market where we will have lunch, homes of movie stars in Beverly Hills, the campus of the University of California at Los Angeles, and other places en route. This special tour will leave Disneyland Hotel at 9:00 a.m. and return at 4:00 p.m. The cost will be $5.50 per person.

CHARTER BUS TO MARINELAND OF THE PACIFIC—MONDAY, JANUARY 30, 1961

If twenty-five (25) people make reservations by Sunday night, January 29, with the Local Arrangements Committee, a Tanner bus will be chartered for direct transportation to Marineland, the world's largest oceanarium. The time from Disneyland Hotel will be from 9:00 a.m. to 4:00 p.m. Transportation cost will be $2.50 per person. Special admission prices to Marineland will be only $1.75 for adults and only 50 cents for children under 17 years. Marineland is the world's only 3-ring sea circus.

STANDARD SIGHTSEEING TOURS BY TANNER GRAY LINE AVAILABLE

The two special charter tours described above will be canceled if there are not the required minimum of twenty-five persons signed up by Sunday night.

All persons planning to take sightseeing tours on Monday, January 30, can do so, however, as all standard tours will be leaving Disneyland Hotel at 7:15 a.m. and again at 12:15 p.m. each day of the week.

RECEPTION FOR TRUSTEES AND COMMISSIONERS MONDAY AFTERNOON

The Board of Trustees of the Orange County Mosquito Abatement District extends its invitation to all Trustees, Commissioners, their families and friends to join them on Monday afternoon between 4:00 and 8:00 p.m. A suitable gathering place at the Disneyland Hotel has been selected where delegates from mosquito control agencies throughout the United States can become acquainted and discuss mutual interests prior to the Conference.

Tuesday—Ladies' Tour and Luncheon

This will be the event arranged especially for the ladies. A chartered bus will leave the hotel at 10:30 for a guided tour to some of the recreational and beauty spots in Orange County. We will visit Newport Beach, Balboa Bay and Lido Isle. Luncheon will be waiting at Victor Hugo's on the cliffs high above the Pacific Ocean at Laguna Beach. In the afternoon we will tour the world famous San Juan Capistrano Mission and then swing back through the 93,000 acre Irvine Ranch, orange groves and beautiful homes.

Tuesday Evening Hospitality and Dinner Dance

All delegates and their wives are cordially invited to enjoy the hospitality of the California Association for an hour or so before Maitre D', Jimmy Lenti serves another of his famous Disneyland Hotel Gourmet Restaurant banquets. Soft and smooth dance music by Ray Livingston's orchestra will provide the atmosphere for dancing during and after dinner until midnight. (Baby-sitters may be reserved in advance through the Hotel Registration Desk).

Disneyland Park

The Magic Kingdom is open Wednesday through Sunday from 10:00 a.m. to 7:00 p.m. Regular tram service takes only minutes from hotel to park. Special Convention rates have been extended to all delegates and their families.

Mosquito Motorcade to San Francisco and Through the San Joaquin Valley

An outstanding Motorcade has been arranged to include visits to several important Mosquito Abatement Districts, the State Health Department Research Headquarters in Fresno and general headquarters in Berkeley. Several side trips have been arranged for those wishing to see world-famous areas such as Yosemite Valley. If you wish to join this Motorcade, please advise the Local Arrangements Committee, P. O. Box 87, Santa Ana, California.

Hotel Accommodations

Disneyland Hotel, the official hotel at Disneyland Park and Headquarters for our Conference, is a year-round resort designed and priced for family fun. Resident Manager, Ray O. Schmitz, has reserved 225 Family Rooms for delegates. The special convention rates of $12.00 applies regardless of whether one or four persons occupy these family rooms. Mail your reservations now to Disneyland Hotel, Anaheim, California. Reservation deadline is January 15, 1961. All reservations received after this date will be on a try-basis. Baby sitting service is available if requested in advance. There are many other motels, at low winter rates within one-half mile radius for those who arrive without reservations.

Mosquito Research Centers in California

Delegates wishing to visit the following organizations engaged in research, bearing upon mosquitoes and their control, and/or other vectors, vector-borne diseases, and their control, may contact the organizations listed:

1. University of California at Los Angeles, Westwood, Los Angeles County, Department of Entomology, Dr. W. Ebeling, Chairman.

   In addition to program of research by Dr. Ebeling and staff in support of the pest control industry, Dr. John N. Belkin is engaged in ecological and taxonomic studies of mosquitoes and other medically significant arthropods.
2. University of California at Riverside, Department of Entomology, Dr. R. L. Metcalf, Chairman.

   One of the nation's foremost pesticide and pesticide use evaluation programs, augmented by ecological and toxicological studies on mosquitoes, flies, aquatic gnats, and terres-

trial gnats (plus a variety of agricultural pests).

3. Co-operative Encephalitis Research Project, Kern General Hospital Grounds, Bakersfield.

   Dr. W. C. Reeves, University of California School of Public Health, Berkeley, and Dr. R. E. Bellamy, U. S. Public Health Service, C.D.C., furnish direction and supervision to an intensive study of the natural history and suppression of mosquito-borne encephalitides, aided by staff of the University of California, the Communicable Disease Center, the Bureau of Vector Control, State Department of Public Health, and the Kern Mosquito Abatement District.

4. Bureau of Vector Control Research Facility, 5545 E. Shields Avenue, Fresno (across from Fresno Airport).

   Dr. A. Ralph Barr, Supervisor of Vector Research, and staff are engaged in ecological, ethological, physiological, toxicological and biological control studies on mosquitoes and other vectors.

5. University of California at Berkeley, Department of Entomology, Dr. R. F. Smith, Chairman.

   Dr. W. M. Hoskins is pursuing studies on insect resistance to insecticides and various other toxicological activities. Dr. D. P. Furman is engaged in parasitological and medical entomology research. Dr. R. L. Usinger is studying various aquatic insects and Dr. E. A. Steinhaus conducts one of the nation's foremost laboratories on insect pathogen research.

6. University of California at Berkeley, School of Public Health, Dr. C. E. Smith, Dean.

   Headquarters of Dr. W. C. Reeves and site of Co-operative Encephalitis Research Project laboratory; various kinds of public health research.

7. State Department of Public Health, Dr. M. H. Merrill, Director.

   Berkeley headquarters.

   Home base of Bureau of Vector Control; location of extraordinary public health laboratory program and facilities; Division of Research (Dr. R. Dyar, Chief) and its various resources.

8. University of California Medical School, G. W. Hooper Foundation, San Francisco.

   Dr. J. R. Audy, Director, (Dr. K. F. Meyer, Director Emeritus) and staff conduct various kinds of medical research related to vector-borne diseases.

9. Communicable Disease Center, San Francisco Field Station, Marine Hospital Grounds, San Francisco.

   Frank M. Prince and staff are engaged in research on plague and other diseases related to rodents and ectoparasites.

10. University of California at Davis, Department of Entomology, Dr. R. M. Bohart, Chairman.

    Dr. Bohart is continuously devoting study to mosquito ecology and taxonomy; Dr. S. F. Bailey is engaged in mosquito flight range studies; Dr. C. L. Judson, of the Bureau of Vector Control, is studying the physiology of mosquito eggs and possible ovicides.

Major effort of the Agricultural Experiment Station is situated on the Davis campus.

PROGRAM SUMMARY

AMCA AND CMCA JOINT MEETING AT DISNEYLAND HOTEL

January 30 – February 2, 1961

Monday, January 30

Board Meeting, American Mosquito Control Assn., Inc.

Open House for Trustees and Commissioners (Host: Orange County M.A.D.)

Tuesday, January 31

Preliminary Business Meeting CMCA
Preliminary Business Meeting AMCA
Welcoming Addresses
"Contrasts" Harold F. Gray, Honorary Member, AMCA and CMCA
Keynote Address—Dr. Malcolm H. Merrill, Director, California SDPH
Summary of Mosquito Control Activities Around the World—Dr. Louis L. Williams, Pan. Am. H.O.
Reports from Various International Health Programs
Hospitality Hour and Dinner Dance

Wednesday, February 1

CMCA Business Meeting
AMCA Business Meeting
EQUIPMENT DEMONSTRATION
Symposium—Relationship of Mosquito Control to Public Well-Being—Dr. J. M. Hirst, Cdr., U. S. Naval Medical School, Moderator
Concurrent—Operational Session
Selected Sectional Reports from feature speakers

Thursday, February 2

Group Breakfast
Invitational Research Papers
Concurrent—Submitted Papers
Concurrent—Trustees and Commissioners Session
Moderator—Charles Scheel
Recess
Summary of Significant Research Development During 1960—
Dr. Don W. Micks, Professor of Medical Entomology, University of Texas Medical School, Galveston
Concurrent—Submitted Papers
Symposium on Recent Developments in Arthropod-borne Viruses in North America—Dr. W. C. Reeves, Moderator, Professor of Epidemiology, University of California, Berkeley, Moderator
Recess
CMCA President's Outgoing Address—Gardner C. McFarland, Manager Southeast M.A.D.
Announcements
ADJOURN

Friday, February 3

Mosquito Caravan to San Francisco Begins

NEWS AND NOTES

AUSTIN W. MORRILL, JR.

NEWS AND NOTES FROM VIENNA. THE PRESIDENT-ELECT SUBSTITUTED FOR THE EXECUTIVE SECRETARY in attending the XI International Congress of Entomology in Vienna, August 17 to 25, 1960. The assignment was carried out with full appreciation of the honor and privilege of representing the AMCA as one of its official delegates. I extend my sympathy to Ted Raley relative to the misfortunes which kept him in California, but I must admit that nothing stopped me from enjoying every minute of the trip. There were extracurricular activities in London, Paris, Switzerland, and Germany which will never be forgotten.

There were many worthwhile papers, and attendance at the Congress was certainly a most rewarding experience. Receptions at the City Hall and the Natural History Museum were noteworthy affairs. The buffet in a University courtyard provided an excellent meeting place for discussions, scientific and not so scientific. Time was available for realization of the beauties of Vienna. I expected to see parks, gardens, baroque and rococo architecture, but all these were even more impressive than I had anticipated. The Hapsburgs knew how to "live it up," and today Vienna again seems happy, energetic, and prosperous.

At the Congress, it proved to be difficult to keep the sessions on schedule, a fact which caused a certain amount of frustration especially since some conflicts in timing which developed were adjusted by transposing blocks of papers from one section to another. This, coupled with the fact that the Museum and the University, where most of the sessions were held, were several blocks apart, resulted in some confusion and missing of papers. However, the route between was through parks filled with fountains and flowers, and flanked by buildings of the greatest artistic and historic interest. To those of us who were interested in the scientific, educational, historic, musical and artistic associations of the meeting rooms themselves, and of the buildings and their surroundings, there was exciting compensation for the fact that some of them were a bit crowded and not always as well suited as could be desired for the best projection of slides.

There were a considerable number of reports on research dealing with behavior of insects. There were discussions of mosquito behavior as related to feeding habits, maintenance and transmission of disease agents, flight habits, insecticide resistance and other activities. "Exophily" was defined by P. F. Mattingly as an avoidance of the human domestic environment. There are indications of a negative correlation between exophily and insecticide resistance.

A. W. A. BROWN is continuing his explorations of the factors which attract mosquitoes to a blood meal. The amino acid, lysine, appears to be an important substance in human blood. Another report by Tony B. dealt with absorption of DDT by the peritrophic membrane. Resistant strains of *Aëdes aegypti* larvae excrete more peritrophic membrane than susceptible strains. There is no doubt that this is a resistance mechanism.

N. Shipitsina reported that careful observations and analyses of phenological data in the U.S.S.R. have been related to the major seasonal processes of *Anopheles maculipennis* and *Plasmodium vivax* to obtain a prognosis for the most rational dates for carrying out antimalarial measures.

Mr. Mattingly arranged a meeting for any and all interested in *Aëdes aegypti*. This was an informal gathering at a restaurant where drinks could be had. There was much talk of genetics, behavior, etc., etc.

Marshall Laird, who spoke on biological control at our Boston meeting, reported in Vienna that his pilot experiment with the fungus *Coelomomyces* in the Tokelay Islands near Fiji was encouraging. He would like to expand investigations along these lines.

There was a very good representation of AMCA members at the Congress, many of whom besides those mentioned above presented papers and contributed much to the symposiums and discussions.

WILLIAM E. BICKLEY

WE ARE INDEBTED TO DR. R. C. WALLIS FOR THE INFORMATION that an interesting part of the session on Encephalitis was a paper by Our Editor, DON COLLINS and the subsequent discussion, in which Prexy DAN JOBBINS took part. Another AMCA'er to present a paper was Major H. D. NEWSON whose paper also touched off a lively discussion in which BICK took an active part. Dr. Wallis also remarked on the vitality of further informal discussions on this vital subject and mentioned Dr. DON MICKS, among others, as having taken part in the post-Congress discussions in WHO Headquarters. It must have been a stimulating experience, being there, and we wish we could all have made it.

OUR OWN MILT BUEHLER has authored a correspondence course in Pest Control which should be a must to any one who would like to brush up his professional backgrounds in basic and applied entomology and is mighty interesting to those whose daily task is to instruct and train workers in practical insect control. Milt's background is, of course, extensive, covering both commercial pest control and management of mosquito abate-

ment prior to his present commitment with the U. S. Navy. The syllabus seems to us to rank right up with Arnold Mallis' classic and authoritative text and received a nice accolade from Dr. J. J. Davis, emeritus professor of entomology at Purdue, the patron saint and prophet of commercial pest control, who certainly needs no introduction from *us*.

The Would-Be Humorous Anger of Our Recent Squib About *Pest Control Magazine* and their threatened rivalry with this Department has brought us a mock-reproachful letter from Jim Nelson, that Journal's redoubtable editor and our fellow AMCA'er. He offers to be friends, so we guess we'd better tell you that *Pest Control,* too, is bringing out a correspondence course, in Pest Control, in 18 lessons, and prepared under Drs. J. J. Davis and John Osmun. The lessons will be published one a month for the next year and a half and, needless to say, *this* course sounds mighty fine too. So, if you remember your Oz books and H. M. Wogglebug, T.E., and yearn to be recondite and string letters after your name, here's your chance. We expect every man jack among us to appear two years from now with F.A.M.C.A., T.E., as a suffix.

Speaking of Higher Degrees, the Pan American Sanitary Bureau is Looking for a Ph.D. in entomology who is willing to go to Latin America on malaria control on a one-year contract for $6,000 per annum, with family allowance and cost-of-living adjustments which vary with the locale of the duty station and the civil service status. We would guess that only a brand-new Ph.D., or a retired one with an assured income would be interested at this salary but the work is of very great importance in the foreign relations of our country and would certainly be extremely stimulating and rewarding otherwise. The entomologist (or Ph.D. in a closely related discipline) would be part of a team of PASB consultants to the country to which assigned and specialized training would be provided prior to assignment. A speaking knowledge of Spanish would be desirable, according to Mr. Martin Bickford, Personnel Officer of the Bureau, at 1501 New Hampshire Avenue N.W., Washington 6, D. C.

Elwood Lynch Reports that Several New Jersey Mosquito Control Superintendents, and a group of specialists headed by President D. M. Jobbins, motored down on 8 June to Ocean City, on the Eastern Shore of Maryland. Maryland was represented by a group including Dr. Bill Bickley and Dr. George Langford. Dr. Langford was toastmaster that evening at the banquet for the occasion, which was one of those famous Eastern Shore, Maryland-style fried chicken dinners, after which Dr. Bickley described the Maryland program and preventive control measures were discussed. Although Maryland's program is only a little over four years old, they were able to show the experienced New Jersey group some very satisfactory progress. Afterward, they were led by Elwood Lynch on a tour of current activities, including typical marshes, the new Eastern Shore Headquarters at Salisbury, an impoundment being operated by the State Fish and Game Commission, and the operation of ditching and spraying equipment in current use.

Dr. E. F. Knipling Was Recently Honored by the U. S. Department of Agriculture which bestowed on him the Distinguished Service Award for outstanding achievement in research and administration. It's no surprise to us, of course, that Knip deserved all this but it is gratifying that the U.S.D.A. finally woke up to it. We make no secret of thinking that our AMCA'ers in the U.S.D.A. honor the Department more than it ever can honor *them,* but Department honors are not distributed lightly.

We've Mentioned Before the Informative (and Provocative) Memoranda Ted Raley Sends us From Time to Time. Since You Are All Coming to California for the Meetings we think you should know that a recent memorandum told about something Californians are prouder of than Disneyland. San Joaquin MAD has now enrolled 100 percent of its Trustees in AMCA, which brings to *four* the number of California MAD's so represented. The others: Southeast, Eastside and San Mateo. Take a bow, Les Brumbaugh, Gardner McFarland, Gordon Smith and Don Grant!

We Are Sure That All of AMCA Is Going to Be Proud of the Meetings Which the California Mosquito Control Association is working up for us. In addition to the meetings themselves there is to be a Mosquito Caravan to San Francisco which will give AMCA'ers a chance to view work being done by the cooperative encephalitis project in Bakersfield, the California Bureau of Vector Control in Fresno, the University of California in its several Bay Area locations, the U. S. Public Health Service Communicable Disease Center field station and others. In this connection John Shanafelt sends us a copy of a letter from Dr. J. D. Mabbett, Chief Health Officer of Brisbane, Queensland, Australia, (the letterhead didn't *say* anything about Australia and we have a little Brisbane near San Francisco, so we were a bit confused by this interest in the caravan, to say nothing of the reference to *Aëdes vigilax.*) Dr. Mabbett expressed an interest in seeing places and talking to people concerned with similar species or species presenting similar problems. Dr. Mabbett's *vigilax* is a salt-water species having a flight range of approximately 40 miles on favorable winds. Ring any bells?

The Sightseeing Tours in the Los Angeles Area Include Highly Interesting Research as Well as Tourist Sites. There is nearby, not only Orange County MAD but also the University of California at Westwood and at Riverside, with

faculties too well known to need introduction. The tourist sites will include a tour for the ladies to famed San Juan Capistrano Mission, of swallow legend, and a luncheon at the Victor Hugo at Laguna, noted for good food as far back as we can remember, which is no mean distance. If reservations are made by Sunday night, 29 January, a tour will be made of Hollywood where for a mere $5.50 a visit will be provided to Grauman's Chinese, home of many a "fabulous premeer," the Brown Derby, the truly fabulous Farmers' Market, U.C.L.A., and a lot more en route. On Monday, for $4.25 *total,* a tour will go to Marineland. Better come early!

ACCORDING TO VIRGINIA'S *Skeeter,* ENCEPHALITIS HAS BEEN ISOLATED FROM 15 OR SO OF THE FAMOUS CHINCOTEAGUE ISLAND PONIES. Fortunately, no human cases appeared, possibly due to the fact that the deaths of the ponies occurred in October. Another late fall problem, heritage of Hurricane Donna, was the unusually large emergence of *Aëdes atlanticus,* the denison of field and woodland ponds and scourge of the hunters of deer and dove. This year: more water, more ponds, more hunters (that is to say, hunters *of* hunters).

IF YOU'VE BEEN READING US AT ALL CLOSELY . . . AND OF COURSE ALL OF YOU *Do* . . . YOU MAY REMEMBER THAT WE'VE BEEN KIDDING CHET ROBINSON about having house fly problems dumped into his lap, sort of, and have also respectfully recorded the magnificent program of public education he stirred up. In August, Chet's Alameda County (Calif.) Mosquito Abatement District, in conjunction with the Farm Advisor's Office, conducted a residual fly control demonstration at a chicken ranch, with some new adulticides, and preliminary results were very promising. Not satisfied with advancing public education in the fly control field, however, Chet also evangelized those perennial problem children, the duck hunters. The cooperation of these clubs, both in redesigning their ponds and in delaying the putting in of the water until late in the season has resulted in what observers have claimed to be the greatest improvement in mosquito control ever obtained in these areas.

GEORGE BURTON WAS THROUGH SAN FRANCISCO A SHORT TIME AGO en route from Kerala, India, to Washington, D. C., via British Guiana. He had with him a fine film strip on filariasis in India which is obtainable from CDC in Atlanta, and showed us also some shots which seemed to us quite remarkable of *Mansonia* larvae attached to the roots of *Pistia* and *Eichhornia.* Some of these photos are reproduced in publications which appeared in the *Indian Journal of Malariology* and described very interesting observations on the attachment habits of *Mansonia.*

AN AMCA'ER WHOM WE USED TO THINK OF AS A FRIEND has sent us a quotation to the effect that, "There's only one thing really wrong with the younger generation . . . a lot of us don't belong to it any more." One AMCA'er to whom this definitely does not apply, however, is DICK GERHARDT, who is proving it by taking a giant step into a new career . . . teaching. Dick has left California (how could he do that?) for Colorado, where he will be an Assistant Professor at Adams State College. His wife and family, caught in the school year routine, will follow when they disentangle. Good luck, Dick, and don't forget your little friends . . . or Us.

ROY FRITZ IS EMBARKING ON A NEW AREA OF HIS OLD CAREER and we wish him luck and bon voyage, too. Roy has been appointed to serve for a period of five years on the World Health Organization's Expert Advisory Panel on Malaria, according to a letter we received from the Office of Public Health of the International Cooperation Administration. Roy is presently Chief of the Malaria Eradication Branch of that office and though we seldom here *from* him we often hear *of* him in one part of the world or another. Ah, youth!

WHILE WE'RE ROUNDING UP ENERGETIC MEMBERS, HERE'S ALSO W. S. MURRAY. Bill is Entomologist for the Area Public Works Office, Chesapeake, the Navy's Potomac district which encloses Washington, and has been for some months the Chairman of the Membership Committee of the Washington Entomological Society. Memberships have been pouring into this venerable society at a great rate from all over. Corresponding Secretary is PAUL WOKE and Recording Secretary, ERNESTINE THURMAN. Need we say more? End of Section on Admiring Our Energetic Members.

SPEAKING OF DICK GERHARDT REMINDS US THAT WHEN TED RALEY SENT US THE LATEST LIST OF AMCA MEMBERS WE WERE INTRIGUED TO NOTE THAT A NUMBER OF MEMBERS HAD THE SAME FAMILY NAMES. We enquired into a few of them and found that we did indeed have several brother or father and son teams and Who's Who this month is dedicated to them. Any one else know of more?

CHARLES E. GERHARDT like Dick (Vol. 18, No. 3), was born in Hillsboro, Illinois, though in 1910, so they aren't twins exactly. Charles attended Illinois College, got his M.S. from the University of Iowa and did graduate work both at Wyoming and Illinois. He is a commissioned officer in the U. S. Public Health Service, with the grade of Director, and is President of the local chapter of the Public Health Service Commissioned Officer Association. He is also a member of the Entomological Society of America, the Association of Tropical Medicine and Hygiene, R.E.S.A., and us. His present address is Charlottesville, Virginia, where he is Chief of Region 3 under the PHS Communicable Disease Center. He still optimistically and hopefully says his work is ento-

mology as well as administration but his only time for hobbies is hunting, a two-weeks a year possibility.

Roy E. Twinn is the son of Dr. C. R. Twinn (Vol. 15, No. 1) and head of his own business, the Twinn Pest Control Co., Ltd., of Ottawa. Roy was born during his father's graduating year at Ontario Agricultural College, at Guelph and attended school in Ottawa. He was a Warrant Officer in the Royal Canadian Air Force as wireless man and air gunner and then switched to the Navy in wireless and radar. At about this same time he married, his wife being then with the Winnipeg Ballet, and with all these talents to draw on, their four children must be a mighty accomplished lot. Roy's hobbies are still flying and boating, and he is a member of the National Pest Control Association, the Canadian Pest Control Operators Association, the Ottawa Flying Club and the Aircraft Owners and Pilots Association.

George and Marco Giglioli are a father and son team, too, and between them they have roamed the world so widely we hardly know where to begin. George (pere) was born in Portici, Italy, in 1897, and attended the University at Pisa, receiving his M.D. in 1921. The next year he went to London and thence as Chief Medical Officer for a large Bauxite Co. in British Guiana, which is where he still is, now as Medical Advisor to the British Guiana Sugar Producers Association. In between he has been malariologist to several sugar estates and to the Government, collecting several honors which include the Order of the British Empire (Officer). He has been a member of the WHO Expert Panels on Malaria and Parasitic Diseases, the Pan American Sanitary Bureau's Advisory Committee on Malaria Eradication in Washington, the Standing Committee for Medical Research in the British Caribbean Territories, and WHO consulting assignments in Mexico (1949), Nigeria (1952), Somalia (1954–57), Afganistan (1956), and Venezuela (1958 and 1960) and lecturer at the Malaria Eradication Center at Kingston, Jamaica, and many other things. His hobby is photography and with all those chances you can see how it would be, as well as soaking off labels from his luggage. Marco (fils), was born in British Guiana and studied there and in Italy and then at McGill University, where he received his B.Sc. with honors, together with the Hiram Mills Medal and the Fantham Memorial Prize. He received his Ph.D. from London and is a Fellow of the Royal Entomological Society, the Royal Society of Tropical Medicine and Hygiene and us. After an assignment with WHO in Liberia, he has for the last three years been with the Medical Research Council doing research in *A. gambiae* in Gambia. His hobby is photography, too. (We'd like to see the pictures!)

Bruce Brockway (Vol. 18, No. 2) and Bradford Brockway comprise our last team, brothers this time, whose father was widely known and highly regarded by mosquito control men and especially by AMCA. Bruce threw a scare into us awhile back when a routine change of address set off a rumor he had left mosquito control, but he has hastened to scotch this. Brad is the President of the Concession Supply Company, whose ads have been so long a feature of *Mosquito News,* and we never knew that until now. Brad was born in 1905 in Toledo, Ohio, and attended school there and in Maryland and finally wound up at Albion College, Michigan, where he received his A.B. After four years in the Navy in WW II., he came back to find that his father and brother needed mosquito traps and added these to his line of manufacture. This has kept him increasingly busy (which astonishes no one who uses his excellent traps—advt.), although his numerous other items would do that anyway. Nevertheless, he is a member of the Masons, the American Legion, Sigma Chi (of which he was Chapter President in Albion and later Alum prex), Sons of the American Revolution, the Chamber of Commerce, past President of the American Recreational Equipment Association, member of the Association of Amusement Parks, Pools and Beaches, the Showman's League, the Toledo Zoological Society and several others. Maybe we should have mentioned him in our list of Most Energetic Members!

We Have Received Requests for Information on the Flight Ranges of Several Species of Mosquito and we don't have much but general impressions, really, to go on. No data at all, in fact. Does anyone know, for instance, what the flight range of *Culex salinarius* is? We have been told it was not far, nothing like so far as that of everybody's friend *Aedes taeniorhynchus,* for example. On the other hand, we've seen reports that it has been known to cruise five, ten and even nineteen miles over water. Does anyone have any records on this, including records on how often such flights have been seen to occur? We'd like to hear.

Chet Robinson's Alameda County (Calif.) Mosquito Abatement District has been educating people on mosquitoes as well as flies lately. At the Alameda County Fair they had a spectacular exhibit which consisted of a thirteen foot *Culex tarsalis* of plywood (painted with all the proper markings with the assistance of Dick Peters' Bureau of Vector Control, consisting of AMCA'ers too numerous to mention individually). The beast has flashing red eyes, a three foot long glass proboscis through which a red fluid bubbled, and legs of black plastic pipe. There were also two bowls, one with mosquito larvae and one with *Gambusia.* During the run of this "show" they distributed 5000 of the District's educational pamphlets. The kind of control they have, though, this was probably the only place most of the constituents ever see a mosquito! (Ah, there, Chet!)

A WORK CONFERENCE ON BLACKFLIES WAS HELD AT QUEEN'S UNIVERSITY, BIOLOGICAL STATION, CHAFFEY'S LOCKS, ONTARIO, SEPTEMBER 23–24, 1960. Twenty-five specialists and other biologists from Canada and the United States were in attendance. The program, under the chairmanship of Dr. B. V. Peterson, included informal discussion sessions on the systematics, ecology, economic importance, and control of the Simuliidae.

The first of these conferences was held at Guelph, Ontario, on November 1, 1958, with fourteen blackfly specialists from the United States and Canada and ten other interested entomologists in attendance. A third conference will be scheduled for sometime in 1962.

The accompanying figure is a photograph of the participants in the second conference, i.e., the one held recently at Chaffey's Locks:

1st row (sitting) from left to right: Dr. G. R. DeFoliart; Mr. F. J. H. Fredeen; Dr. H. E. Welch; Dr. B. V. Peterson; Dr. G. F. Bennett; Dr. L. Davies; Dr. K. R. Rothfels; Mr. D. G. Peterson.

2d row (kneeling): Dr. K. M. Sommerman; Dr. D. M. Davies; Mr. H. G. James; Dr. A. M. Fallis; Dr. A. S. West; Mr. G. E. Shewell.

3d row (standing): Dr. F. Whiting; Dr. P. K. Basrur; Mr. R. W. Dunbar; Mr. J. Pasternak; Dr. H. A. Jamnback; Dr. A. P. Arnason; Mr. R. J. Phelps; Mr. D. M. Wood; Dr. A. Stone; Dr. J. R. Anderson.

—B. V. Peterson, Entomologist,
Canada Dept. of Agriculture

BLACK FLY BIBLIOGRAPHY. 26 pages. Offset. Copies available free from C. W. McComb, Assistant, Department of Entomology, University of Maryland, College Park, Md.

WILLARD WILSON YATES

1888–1960

On April 16, 1960, Willard Wilson Yates passed away suddenly at his home in Corvallis, Oregon. Mr. Yates' entire career was spent in chemical and entomological research. He leaves a host of friends and fellow workers in all parts of the country who know of his devotion and dedication to research along these lines.

Mr. Yates was born on June 16, 1888, at Juneau, Wisconsin, the son of John and Esther Yates. He attended the University of Wisconsin for two years before serving in the U. S. Army during World War I. An old diary discloses that he fought for 21 days in the Argonne Forest. After returning from war duty, he continued with his education and graduated from Oregon State College in 1921. From 1921 until 1926 Mr. Yates served as Assistant Chemist at Oregon State College, after which he worked for private industry for several years, returning in 1932 to receive his M.S. degree.

From 1931 to 1946 Mr. Yates was employed at Portland, Oregon, by the U. S. Department of Agriculture under the old Bureau of Entomology and Plant Quarantine. Most of his time was devoted to the study of mosquito problems in and around that area. He was also concerned with the encephalitis outbreak which occurred in Yakima Valley, Washington. In 1942 he was called to Orlando, Florida, for five months to work with other top research men of the country on the vital problem of pest control for the Army.

In 1946 his group moved from Portland to Corvallis, Oregon, which became his permanent home. He continued work on mosquito and house fly attractants, mosquito larvae sprays, and the use of radioactive isotopes in tagging insects for flight-range studies. Alone, and with other workers, he published manuscripts on these and related projects. In 1952 Mr. Yates retired from active work but always maintained a keen interest in his chosen profession.

Mr. Yates had great personal integrity; he was courteous and modest and never spoke unfavorably of anyone. His intimates recognized and appreciated his great loyalty to them and to his organization. He could be depended on to carry out research assignments no matter how much work was involved. He was an excellent team worker and took great pride in the accomplishments of the group with whom he was associated.

He was married to Phoebe Chamberlain on December 28, 1921, who survives. He is also survived by one daughter, Mrs. Melvin Shaw of Salem, Oregon; two sons, Dr. Morris Yates, a member of the faculty at Iowa State University, and Dr. Ross Yates, a member of the faculty at Lehigh University at Bethlehem, Pennsylvania; one sister, Mrs. Laura Greenfield of Portland, Oregon; and four grandchildren.

He was a member of the American Mosquito Control Association, the American Legion, the Methodist Church of Corvallis, the National Association for Retired Civil Service Employees, the Entomological Society of America, and past president of the Oregon State Entomological Society. His engrossing hobby was stamps; over a period of years he acquired an outstanding collection. He was also an active member of the Corvallis Stamp Club.—C. M. Gjullin and A. W. Lindquist.

REFERENCES TO LITERATURE OF INTEREST TO MOSQUITO WORKERS AND MALARIOLOGISTS

HELEN SOLLERS

Plant Pest Control Division, Agricultural Research Service, United States Department of Agriculture, Washington 25, D. C.

AEROSOLS

PRÍVORA, M. and VYCHODIL, J. 1959. Field disinfestation measures with hot oil aerosols. I. Control of mosquitoes. Ceskoslov. Epidemiol., Mikrobiol. Imunol. (Prague) 8(3):208–211. In Czech., Engl. Sum.

SALMELA, J., SIDLOW, A. J. and DAVIS, A. N. 1960. A new thermal aerosol generator for dispersing insecticidal fogs from a Stearman airplane. Fla. Anti-Mosquito Assoc. Ann. Rpt. 31: 27–31.

ADULTICIDES AND LARVICIDES

BARRERA, A. 1959. Investigaciones sobre la efectividad del malathion en *A.* (*A.*) *pseudopunctipennis* de la Zona Morelense de resistencia al dieldrin y en *A.* (*N.*) *albimanus* de insectario y de la Costa Grande de Guerrero. CNEP Bol. 3(3):18–30. Engl. Sum.

CARTER, R. G., GILBERT, H. L. and LAMB, J. T. 1960. A report from Virginia on mosquito larvae control with paris green vermiculite. Pest Control 28(9):21–22.

DAVIS, A. N., SALMELA, J. and SPENCER, C. B., JR. 1960. Field tests with malathion fogs dispensed from an airplane for the control of adult salt-marsh mosquitoes. Fla. Anti-Mosquito Assoc. Ann. Rpt. 31:18.

GILLIES, M. T. and SMITH, A. 1960. The effect of a residual house-spraying campaign in East Africa on species balance in the *Anopheles funestus* group. The replacement of *A. funestus* Giles by *A. rivulorum* Leeson. Bul. Ent. Res. 51(2):243–252.

HOCKING, K. S., ARMSTRONG, J. A. and DOWNING, F. S. 1960. Gamma-BHC/Cereclor—a new, long-acting lindane formulation for malaria control. WHO Bul. 22(6):757–765.

KACHROO, P. 1959. Preliminary laboratory observations on the role of common weedicides as larvicides. Natl. Soc. India for Malaria and other Mosquito-Borne Dis. Bul. 7(5):151–154.

LABRECQUE, G. C., GAHAN, J. B. and WILSON, H. G. 1960. Residual effectiveness of some new insecticides against adults of *Anopheles quadrimaculatus* Say. Fla. Anti-Mosquito Assoc. Ann. Rpt. 31:17.

MENON, P. B. 1959. Studies on mosquito larvicides. I. Mosquito control oil. Arm. Forces Med. Jour. India 15(3):151–155.

PAL, R. 1960. Use of pyrethrum in vector control. WHO Bul. 22(5):595–599. [Includes mosquitoes.]

RAI, L. and LEWALLEN, L. L. 1960. Insecticide granules compared with emulsion concentrate sprays as mosquito larvicides. Calif. Mosquito Cont. Assoc. Proc. 28:29.

ROGERS, A. J. and RATHBURN, C. B., JR. 1960. Airplane application of granular paris green mosquito larvicide. Fla. Anti-Mosquito Assoc. Ann. Rpt. 31:22–26.

SACHSE, R. 1960. Bericht über die ergebnisse von grossaktionen zur stechmücken und stechfliegenbekämpfung in den überschewemmungsgebieten der Niederlausitz des jahres 1958. Ztschr. f. d. g. Hyg. u. ihre Grenzgebiete (Berlin) 6(1):7–19.

VARIOUS TYPES OF CONTROL

LEWALLEN, L. L. 1960. Integration of chemical and biological control of mosquitoes. Calif. Vector Views 7(5):29–31.

PEPPER, B. B. 1960. State responsibilities in mosquito control activities. N. J. Dept. Health, Pub. Health News 41(4):139–140.

CONTROL PAPERS FROM CALIF. MOSQUITO CONTROL ASSOC. PROC. 28:

BARNES, J. S. 1960. Cooperative relationship between mosquito abatement and conservation agencies. pp. 69–70.

BRAWLEY, J. H. 1960. Problem-solving. p. 106.

CAMPBELL, E. 1960. Urban mosquitoes; their habits and control. pp. 102–103.

FIREMAN, M. F. 1960. Soil problems as they affect abatement districts. pp. 75–78.

HAURET, N. F. 1960. Problem solving by southern California districts. pp. 106–107.

MCCART, R. 1960. Chemical weed control in drain ditches. p. 79.

MULHERN, T. D. 1960. Varied manifestations of mosquito source reduction in California. pp. 80–82.

PANEL ON SOURCE REDUCTION PROGRESS BY MOSQUITO ABATEMENT DISTRICTS. 1960. pp. 75–84. (G. Whitten, Moderator).

REED, D. E. 1960. Economic significance of return flow system as used in Tulare M. A. D. pp. 82–83.

ROBINSON, E. C. 1960. Transition in an urbanized mosquito district. p. 105.

SHANAFELT, J. G., JR. 1960. Urban mosquitoes, their habits and control in Orange County, California. pp. 103–104.

SILVEIRA, S. M. 1960. Minimizing mosquito production on sewer farms by proper planning. pp. 83–84.

SWEET, C. A. 1960. Problems of mutual concern to California's mosquito abatement districts and water pollution control boards. pp. 70–73.

ANNUAL REPORTS FROM FLA. ANTI-MOSQUITO ASSOC. ANN. RPT. 31:

BEIDLER, E. J. 1960. Indian River Mosquito Control District. 1959. pp. 75–77.

BRONSON, A. L. 1960. Suwanee County arthropod control. p. 113.

DANIELL, C. E. 1960. Gulf County Mosquito Control Unit. pp. 64–65.

EADS, D. 1960. Madison County Health Department. Madison County Mosquito Control Program. p. 88.

FERNALD, L. L. 1960. Pinellas County Anti-Mosquito District. pp. 97–100.

GAGE, L. L. 1960. East Flagler Mosquito Control District. 1959. pp. 56–58.

GILMORE, K. P. 1960. Washington County Arthropod control program. p. 117.

GLASS, A. D. 1960. Annual report. Walton County Health Department-Mosquito Control Program. p. 117.

GORMAN, J. D. 1960. Hillsborough County Health Department Mosquito Control Unit. pp. 66–74.

HARDEN, F. W. 1960. Saint Lucie County Mosquito Control District. pp. 103–109.

HUNT, P. J. 1960. East Volusia County Anti-Mosquito District. pp. 114–116.

KARR, G. A. 1960. (Lee County). Fort Myers Beach Mosquito Control District. pp. 80–81.

MADDEN, J. C. 1960. Okaloosa County Health Department-Arthropod Control. p. 95.

———. 1960. Santa Rosa County Health Department-Arthropod Control. p. 111.

MAY, B. E., JR. 1960. Levy County Health Department-mosquito control unit. pp. 86–87.

MCGOVERN, E. E. 1960. Escambia County Arthropod Control Program. pp. 59–63.

MESSER, A. L. 1960. Bay County pest control. pp. 35–36.

MILLER, T. W., JR. 1960. Lee County Mosquito Control District. pp. 82–85.

SALMELA, J. 1960. Brevard Mosquito Control District. pp. 37–40.

SOUDER, C. D., JR. 1960. Broward Anti-Mosquito District 1959. pp. 41–46.

STUTZ, F. H. 1960. Dade County Mosquito Control Division 1959. pp. 51–53.

TANNER, F. F. 1960. Lake County Health Department Arthropod Control Program 1959. pp. 78–79.

TAYLOR, D. 1960. Taylor County Health Department-Arthropod Control. p. 112.

THOMAS, W. G. 1960. Charlotte County mosquito control. pp. 47–48.

WARNER, W. W. 1960. Monroe County Anti-Mosquito District. pp. 92–94.

———. 1960. Polk County Arthropod control. pp. 101–102.

WATSON, B. G. 1960. Naples Mosquito Control District Collier County. pp. 49–50.

WHITTAKER, W. B. 1960. Orange County Arthropod-Control Program. p. 96.

WHITTLESEY, J. P. 1960. East Duval County Mosquito Control District. pp. 54–55.

WILLIAMS, J. M. 1960. Sarasota County Mosquito Control District. p. 110.

WITHAM, M. A. 1960. Martin County Anti-Mosquito District. pp. 89–91.

PARASITES AND PREDATORS

KELLEN, W. R. 1960. Recent advances in biological control in mosquito abatement. Calif. Mosquito Cont. Assoc. Proc. 28:87–88.

MARKS, E. N. and LAVERY, H. H. 1959. Australian wild ducks as mosquito predators. Austral. Jour. Sci. 22(5):216–217.

RIOUX, J. A. and PECH, J. 1960. *Coelomomyces grassei* n. sp. parasite d'*Anopheles gambiae* Giles (note préliminaire). Acta Trop. 17(2): 179–182.

ATTRACTANTS AND REPELLENTS

BROUWER, R. 1960. The attraction of carbon dioxide excreted by the skin of the arm for malaria mosquitoes. Trop. and Geog. Med. 12(1): 62–66.

RESISTANCE AND SUSCEPTIBILITY

COOMES, R. K. and BENNETT, J. 1959. Use of World Health Organization mosquito test kits with DDT resistant *Drosophila*. Ill. State Acad. Sci. Trans. 52(3/4):151–155.

HECHT, O., MANCERA, O. and BARRERA, A. 1960. Relation of DDT-irritation threshold to knock-down of three species of anopheline mosquitoes. Jour. Econ. Ent. 53(4):634–640.

HOLSTEIN, M. H., CULLEN, J. R. and RIVOLA, E. 1960. Seasonal variations in the susceptibility of *Anopheles gambiae* to dieldrin. WHO/Mal/269. 3 pp.

KALRA, R. L. and PAL, R. 1959. Metabolic degradation of D.D.T. in resistant *A. subpictus*. Natl. Soc. India for Malaria and other Mosquito-Borne Dis. Bul. 7(4):123–124.

KRISHNASWAMI, A. K., PATTANAYAK, S. and RAGHAVAN, N. G. S. 1959. The susceptibility of *Culex fatigans* to different densities of Mf. bancrofti. Indian Jour. Malariol. 13(4):153–157.

KUHLOW, F. 1960. Normal susceptibility

levels of *Anopheles pharoensis* Theobald to DDT and dieldrin. Nature (London) 186(4722):410.

MARTÍNEZ PALACIOS, A. 1959. La prueba de Muralla un método simple para determinar la susceptibilidad de los mosquitos. CNEP Bol. (México) 3(3):33–37. Engl. Sum.

———. 1959. Las pruebas de susceptibilidad de los vectores de paludismo en México durante 1958 y 1959. CNEP Bol. (México) 3(4):27–36. Engl. Sum.

———. 1959. Resistencia fisiológica al dieldrín en México de *A.* (*N.*) *albimanus* Wiedemann, 1821. CNEP Bol. México 3(2):19–21.

———. 1959. Resistancia fisiologica a dieldrin y DDT de *A.* (*A.*) *quadrimaculatus* Say 1824, en México. CNEP Bol. (México) 3(3): 31–32. Engl. Sum.

PAL, R. and BHALLA, S. 1959. Multiple resistance in *Anopheles subpictus*. Natl. Soc. India for Malaria and other Mosquito-Borne Dis. Bul. 7(5):135–143.

PERRY, A. S. 1960. Investigations on the mechanism of DDT resistance in certain anopheline mosquitoes. WHO Bul. 22(6):743–756.

RAFI, S. M. 1960. A preliminary report on resistance of mosquitoes to insecticides. Pakistan Jour. Health 9(4):232–237.

RAMACHANDRA RAO, T., BHATIA, S. C. and DEOBHANKAR, R. B. 1960. Observations on dieldrin resistance in *Anopheles culicifacies* in Thana District, Bombay State, India. WHO/Mal/270, WHO/Insect./114, 7 pp.

SACCA, G. and GUY, Y. 1960. Résistance de comportement au DDT chez *A. labranchiae* au Maroc. WHO Bul. 22(6):735–741.

SEN, P. 1959. Insecticide resistance in the mosquito *Culex fatigans* Wied. in Calcutta. Calcutta Schl. Trop. Med. Bul. 7(3):109–110.

STEYN, J. J. and COWORKERS. 1959. Simplified technique for detecting physiological resistance to BHC *Anopheles gambiae*. Pub. Health (Johannesburg) 25(3):35–37. In Afrik., Engl. Sum.

UNGUREANU, FR., TEODORESCU, A., CRISMARU, V. and EVA, E. 1959. Recherches sur la sensibilité aux insecticides des *Anopheles* de la région du nord de la R. P. R. (Région de Jassy). Acad. R. P. R., Fil. Iasi, Stud. Cercet. Stiint. (Med.) 10(1):123–127. In Roum., Fr. Sum.

WOOD, R. J., 1959. Insecticide resistance in mosquitoes. Ann. Applied Biol. 47(3):620–625.

INSECTICIDES AND CHEMICALS

KENAGA, E. E. 1960. Commercial and experimental organic insecticides. (1960 revision). Indexed as to their scientific, common and trade names, code designations, uses and manufacturers. Ent. Soc. Amer. Bul. 6(2):53–79.

MULLA, M. S. 1960. Criteria for selecting granular insecticides for vector control. Calif. Mosquito Cont. Assoc. Proc. 28:27–29.

ODEN, T. 1959. The effect of the sunlight on some organic phosphorous insecticides. Bitki Koruma (Ankara) 1(1):24–26. In Turk., Engl. Sum.

SMITH, C. N. 1960. New approved common names of insecticides. Jour. Econ. Ent. 53(4): 677.

SUZUKI, T. 1960. A method for estimating the effect of insecticides in a field test. Jap. Jour. Expt. Med. 30(1):67–74. In Engl.

SYMPOSIUM: The place of granular insecticides in California vector control. 1960. Calif. Mosquito Cont. Assoc. Proc. 28:26–33. (Moderator, T. G. Raley).

WORLD HEALTH ORGANIZATION. Expert Committee on Insecticides. 1960. Insecticide resistance and vector control; tenth report. WHO Tech. Rept. Ser. 191, 98 pp.

TOXICOLOGY

TRACY, R. L., WOODCOCK, J. G. and CHODROFF, S. 1960. Toxicological aspects of 2, 2-dichlorovinyl dimethyl phosphate (DDVP) in cows, horses and white rats. Jour. Econ. Ent. 53(4):593–601.

WORLD HEALTH ORGANIZATION. 1960. Bibliography on pesticides toxicity and accidental poisoning. WHO/Insect./112, 4 pp.

BEHAVIOR, BIOLOGY AND ECOLOGY

DIJK, W. J. O. M., VAN. 1960. Notes on the breeding of mosquitoes in fishponds in Netherlands New Guinea. S. Pacific Comm. Noumea, New Caledonia. Tech. Inform. Cir. 37:3–8.

DIVISION OF MALARIA ERADICATION, WORLD HEALTH ORGANIZATION AND LISTER INSTITUTE OF PREVENTIVE MEDICINE. 1960. A study of the blood-feeding patterns of *Anopheles* mosquitoes through precipitin tests. Results of collaborative work for the period 1955–59 and their application to malaria eradication programmes. WHO Bul. 22(6):685–720.

ELTON, C. S. 1959. Swarming of male *Culex pipiens L.* (Dipt., Culicidae). Ent. Monthly Mag. 95(1143):189–190.

HANNEY, P. W. 1960. Some notes on the insect fauna of crab holes in Northern Nigeria. Entomologist 93(1164):99–100. [Mostly mosquitoes.]

HUANG, Y. S., CHEN, K. K. and LIU, L. B. 1959. Studies on the feeding habits of mosquitoes in Foochow. Acta Microbiol. Sinica 7(3): 209–216. In Chin., Engl. Sum.

HUSBANDS, R. C. 1960. Advances in population measurement. Calif. Mosquito Cont. Assoc. Proc. 28:85–86.

KALMUS, H. and HOCKING, B. 1960. Behaviour of *Aedes* mosquitoes in relation to blood-feeding and repellents. Entomologia Exper. et Applicata. (Amsterdam) 3(1):1–26.

KNOTT, W. 1959. Niederrheinische stechmücken: ein beitrag zur ökologie der culiciden. Hydrobiologia 13(1/2):1–127.

KRISHNAN, K. S., BHATNAGAR, V. N. and RAGHAVAN, N. G. S. 1959. Effect of overcrowding of *C. fatigans* larvae in laboratory breeding pans. Natl. Soc. India for Malaria and other Mosquito-Borne Dis. Bul. 7(4):131–132.

KRISNAMURTHY, B. S. and PAL, R. 1959. A note on the comparative effect of different blood feed on egg production of *C. fatigans*. Natl. Soc. India for Malaria and other Mosquito-Borne Dis. Bul. 7(1):27–29.

KURIHARA, Y. 1959. Synecological analysis of the biotic community in microcosm. VIII. Studies on the limiting factor in determining the distribution of mosquito larvae in the polluted water of bamboo container, with special reference to relation of larvae to bacteria. Jap. Jour. Zool. 12(3): 391–400.

LIU, L. B., WONG, K. C., CHEN, K. K. and WU, S. M. 1960. One year's observations on the development and habits of *A. sinensis* and *C. fatigans* in Foochow. Acta Ent. Sinica 10(1): 86–95. In Chin., Engl. Sum.

MUIRHEAD-THOMSON, R. C. 1960. The significance of irritability, behaviouristic avoidance and allied phenomena in malaria eradication. WHO Bul. 22(6):721–734.

PEÑA DE GRIMALDO, E. and LAVOIPIERRE, M. M. J. 1960. Efecto de la fertilizacion sobre la ovopostura de los mosquitos *Aedes aegypti* variedad *queenslandensis*, con algunas observaciones sobre anomalias y viabilidad de los huevos retenidos por los mosquitos esteriles fecundizados a diferentes intervalos despues de la comida de sangre. Rev Ibérica de Parasitol. 20(2):163–176. Engl. Sum.

———. 1960. 1. The effect of delayed mating on egg-laying by *Aedes aegypti* var. *queenslandensis*. 2. The longevity of mated and unmated *Aedes aegypti* var. *queenslandensis*. 3. The effect of blood meals from different animals on egg-laying by *Aedes aegypti* var. *queenslandensis*. Roy. Soc. Trop. Med. and Hyg. Trans. 54(1):6–7.

PETERS, W. and STANDFAST, H. A. 1960. Studies on the epidemiology of malaria in New Guinea. Part II. Holoendemic malaria—the entomological picture. Roy. Soc. Trop. Med. and Hyg. Trans. 54(3):249–260.

POTAPOV, A. A. 1960. The vegetation in the shallows of the Gorky and Kuibyshev water reservoirs and possible breeding of mosquitoes, gadflies and blackflies therein. Med. Parazit. i Parazit. Bolezni 29(3):341–345. In Rus., Engl. Sum.

RAMACHANDRAN, C. P. 1960. The culture of *Mansonia*, using an aquatic plant—*Salvinia*. Roy. Soc. Trop. Med. and Hyg. Trans. 54(1):6.

ROSAY, B. 1960. Advances in behavioral studies. Calif. Mosquito Cont. Assoc. Proc. 28: 88–89.

SAFYANOVA, V. M. 1960. Material on the ecology of bloodsucking mosquitoes in the Vladimir Region. Zool. Zhurnal 39(2):236–243.

SNOW, W. E., PICKARD, E. and HAWKINS, J. L. 1960. Observations on the biology of *Psorophora cyanescens*. Jour. Econ. Ent. 53(4):619–621.

SURTEES, G. 1959. Studies on the oviposition behaviour and development of the type form of *Aedes aegypti* L. (Dipt., Culicidae). I.—Breeding site dimensions. Ent. Monthly Mag. 95 (1145):220–221.

VINOGRADOVA, E. B. 1960. Experimental investigation of ecological factors inducing imaginal diapause in bloodsucking mosquitoes (Diptera, Culicidae). Ent. Obozr. 39(2):327–340. In Rus., Engl. Sum.

WALDRON, W. G. 1960. Overwintering of *Culex tarsalis*. Calif. Vector Views 7(8):51.

WOODHILL, A. R. 1959. Experimental crossing of *Aedes* (*Stegomyia*) *aegypti* Linnaeus and *Aedes* (*Stegomyia*) *albopictus* Skuse (Diptera, Culicidae). Linn. Soc. N. S. Wales Proc. 84(390): 292–294.

GENETICS

RISHIKESH, N. 1959. Chromosome behaviour during spermatogenesis of *Anopheles stephensi* sensu stricto. Cytologia 24(4):447–458.

ANATOMY, MORPHOLOGY AND PHYSIOLOGY

BELKIN, J. N. 1960. Innervation as a criterion of homology of the elements of the larval and pupal chaetotaxy of mosquitoes. Ent. Soc. Wash. Proc. 62(3):197.

BIRD, R. G., BERTRAM, D. S. and NYE, E. R. 1960. Some preliminary electron micrographs of an arbor virus, and the anatomy of its mosquito vector. Roy. Soc. Trop. Med. and Hyg. Trans. 54(1):3.

BOORMAN, J. P. T. 1960. Observations on the feeding habits of the mosquito *Aedes* (*Stegomyia*) *aegypti* (Linnaeus): the loss of fluid after a blood-meal and the amount of blood taken during feeding. Ann. Trop. Med. and Parasitol. 54(1):8–14.

GONDA, O., KALUSZYNER, A. and AVI-DOR, Y. 1959. Effect of 1:1:1-trichloro-2:2-di-(p-chlorophenyl) ethane (DDT) and related compounds on the adenosine triphosphate-phosphate exchange catalysed by a particulate fraction from the mosquito. Biochem. Jour. 73(4):583–587.

JUDSON, C. L. 1960. Advances in knowledge of aedine eggs. Calif. Mosquito Cont. Assoc. Proc. 28:86–87.

LARSEN, J. R. and BODENSTEIN, D. 1959. The humoral control of egg maturation in the mosquito. Jour. Expt. Zool. 140(2):343–380.

RAMAKRISHNAN, S. P. and MOHAN, B. N. 1959. Distention of the abdomen of *Culex fatigans*, a sign of acute poisoning by gamma BHC. Indian Jour. Malariol. 13(4):189–197.

SHALABY, A. M. 1959. Forced retention of eggs in *Culex* (*Barraudius*) *pusillus* Macq. (Diptera: Culicidae). Indian Jour. Malariol. 13(4): 199–208.

———. 1959. The mouth parts of the larval instars of *Psorophora howardii* (Coquillett) (Diptera: Culicidae). Soc. Ent. Egypte Bul. 43: 203–230.

TECHNIQUES

BIDLINGMAYER, W. L. 1960. A project to sample mosquito populations in flight. Fla. Anti-Mosquito Assoc. Ann. Rpt. 31:32–34.

BRENNAN, J. M. and MAKI, W. A. 1960. An inexpensive and effective indoor insectary. Jour. Econ. Ent. 53(4):685–688. Illus. [Used for *Culex tarsalis*.].

GARNHAM, P. C. C., BIRD, R. G. and BAKER, J. R. 1960. Electron microscope studies of motile stages of malaria parasites. I. The fine structure of the sporozoites of *Haemamoeba* (= *Plasmodium*) *gallinacea*. Roy. Soc. Trop. Med. and Hyg. Trans. 54(3):274–278.

HAEGER, J. S. 1960. A technique for rearing *Mansonia* (*Mansonia*) *titillans* (Walker) in the laboratory. Preliminary studies on plant preference for egg laying and larval attachment to plant and artificial material. Fla. Anti-Mosquito Assoc. Ann. Rpt. 31:19–21.

SHUTE, P. G. and MARYON, M. 1960. Laboratory technique for the study of malaria. 86 pp., London.

SPENCER, M. 1959. Recognition of individual nulliparous and parous mosquitoes. Austral. Jour. Sci. 22(4):169–170. [*Anopheles farauti*.]

TAXONOMY

BRUIJNING, C. F. A. 1959. Notes on *Wyeomyia* mosquitoes of Suriname, with a description of *Wyeomyia surinamensis* sp. n. *In* Geijskes, D. C. and Hummelinck, P. W. Studies on the fauna of Suriname and other Guyanas. III. pp. 99–146.

BULLOCK, H. R. 1960. Chorionic pattern of *Aedes* eggs by SUMP method. Amer. Microscop. Soc. Trans. 79(2):167–170.

CORRÊA, R. R. and RAMALHO, G. R. 1959. *Culex* (*Culex*) *deanei*, nova espécie do género *Culex* Linnaeus, 1758 (Diptera, Culicidae). Inst. Med. Trop. São Paulo Rev. 1(2):141–143. Engl. Sum.

GUY, Y. 1959. Les sous-espèces marocaines d'*Anopheles claviger* Meigen (1804). Soc. des Sci. Nat. et Phys. du Maroc Bul. 39(1):9–12.

———. 1959. Mise en synonymie d'*Anopheles turkhudi myzomyifacies* Gaud, avec *Anopheles hispaniola Theobald*. Soc. des Sci. Nat. et Phys. du Maroc Bul. 39(1):13–18.

LANE, J. and RAMALHO, G. R. 1960. A new neotropical *Culex*. Rev. Brasil. Ent. 9:173–176. [*C. renatoi* sp. n.]

MARKS, E. N. 1958. New species and records of the *Aedes kochi* group from eastern Australia (Diptera: Culicidae). Roy. Soc. Queensland Proc. 69:57–74. [*A. josephinae* and *A. dobrotworskyi* both sp. n.]

MCCLELLAND, G. A. H. 1960. Variation in the abdominal color pattern of *Aedes aegypti* (L.). Roy. Soc. Trop. Med. and Hyg. Trans. 54 (1):4.

MIHÁLYI, F 1959. Revision der aus dem karpatenbecken stammenden stechmücken der ungarischer dipteren-sammlungen. Rovartani Közlemények (Fol. Ent. Hung.) n. s. 12(12): 139–162. [Includes *Aedes, Culex* et al.]

OHMORI, Y. 1959. The pupae of Japanese *Anopheles*. Jap. Jour. Sanit. Zool. 10(4):219–225.

SERVICE, M. W. 1960. A taxonomic study of *Anopheles funestus funestus* Giles (Diptera: Culicidae) from Southern and Northern Nigeria, with notes on its varieties and synonyms. Roy. Ent. Soc. London Proc. Ser. B. 29(5/6):77–84.

DISTRIBUTION

BELOKUR, V. M. 1960. On the fauna of blood-sucking Diptera of the Nenetz national region and the north part of Komi A. S. S. R. Ent. Obozr. 39(2):404–409. In Rus., Engl. Sum. [Includes mosquitoes.].

BOZHKOV, D. K. 1959. Beitrag zur erforschung der stechmückenfauna in Rodopen- und Rilagebirge. Bulgar. Akad. na Nauk. Zool. Inst. Izv. 8:109–118. In Bul., Ger. Sum.

———. 1959. Eine für die fauna Bulgariens neue art blutsgende stechmücke. Compt. Rend. Acad. Bulgare Sci. 11(6):501–502. In Bulg. [*Culiseta longiareolata*.]

DIMOV, Iv. 1959. De nouveaux moustiques pour la faune de la Bulgarie. Compt. Rend. Acad. Bulgare Sci. 12(2):169–172.

DOBY, J. M. and MOUCHET, J. 1959. Présence de *Culex philipi* Edwards, 1929, *Culex guiarti* Blanchard, 1905, et de *Culex sitiens* Wiedemann, 1828 au Cameroun. Complément à l'étude écologique des culicides larvaires dans la région de Yaondé. Vie et Milieu 10(4):417–420.

HARA, J. 1959. Two new mosquito records from Japan (Diptera: Culicidae). Taxonomical and ecological studies on mosquitoes of Japan. (Part 13). Jap. Jour. Sanit. Zool. 10(4):225–229. [*Aedes christophersi, A. oreophilus*.]

LAMBRECHT, F. L. 1959. Culicides récoltés au Bugesera (Ruanda). Rev. Zool. et de Bot. Afr. 60(3/4):352–353.

LIPS, M. 1960. *Anophèles* du Congo Belge. 2. Quelques espèces des galeries forestières. Riv. di Parassitol. 21(1):39–64.

PODENAITE, V. 1959. The fauna of blood-sucking mosquitoes in the Lithuanian SSR. Acta Parasit. Lithuanica 2(1):89–96. In Rus., Engl. Sum.

REMM, H. 1959. Zur kenntnis der dipterenfauna vom Avaste-Moor. Ent. Kogumik (Tartu) No. 1:102–113. In Esthon. [Includes mosquitoes.]

RIOUX, J. A. and NICOLI, M. 1959. *Anopheles maculipennis subalpinus* et *Orthopodomyia pulchripalpis* culicides nouveaux pour la Corse (Diptera, Culicidae). Cah. Natural. (Paris) n. s. 15 (3):73–74.

SICART, M. 1959. Présence de *Culex torrentium* dans le Puy-de-Dôme. Soc. Hist. Nat. Toulouse Bul. 94(3/4):357–358.

SUZUKI, K. 1959. Notes on two species of the subgenus *Ochlerotatus* (gen. *Aedes*) from Hokkaido, Japan (Culicidae, Diptera). Dobutsugaku Zasshi (Tokyo) 68(8):291–296. Engl. Sum. [*Aedes hexodontus* and *A. intrudens.*]

SZTANKAY-GULYÁS, M. 1959. Theobaldia *glaphyroptera* Schiner 1864. Eine neue art in der Ungarischesn stechmückenfauna. Fol. Ent. Hungarica 11(23):399–402. [*Culiseta glaphyroptera.*]

ENCEPHALITIS

BEADLE, L. D. 1960. Arthropod-borne encephalitis: a rising problem. Fla. Anti-Mosquito Assoc. Ann. Rpt. 31:34A-34G.

COLLINS, D. L. 1960. Status of eastern equine encephalitis and the mosquito vector potential in New York State. N. Y. State Jour. Med. 60(8):1225–1229.

DOWNS, W. G. and ANDERSON, C. R. 1959. Arthropod-borne encephalitic viruses in the West Indies area. Part I. A serological survey of Grenada, W. I. West Indian Med. Jour. 8(2): 101–109.

JOHNSON, H. N. 1960. Encephalitis and research. Calif. Mosquito Cont. Assoc. Proc. 28: 11–15.

LONGSHORE, W. A. and COWORKERS. 1960. California encephalitis surveillance program: relationship of human morbidity and virus isolation from mosquitoes. Amer. Jour. Hyg. 71(3): 389–400.

LOOMIS, E. C. and MEYERS, E. G. 1960. California encephalitis surveillance program; mosquito population measurement and ecologic considerations. Amer. Jour. Hyg. 71(3):378–388.

MAYYASI, S. A. SLOTNICK, V. and BROWN, A. 1960. The adaptation of Venezuelan equine encephalomyelitis virus to cell cultures derived from monkey brain. Jour. Infect. Dis. 106(2): 193–196.

PANEL ON EASTERN ENCEPHALITIS. Hayes, R. O. (Moderator). 1960. Mosquito News 20(2): 83–85. [Others on panel were R. W. Chamberlin, D. M. Stamm, R. C. Wallis and D. M. Jobbins.]

FILARIASIS

BEYE, H. K. and WRIGHT, W. H. 1959. The National Filaria Control Program (N. F. C. P.) of India: investigative challenges. Natl. Soc. India for Malaria and other Mosquito-Borne Dis. Bul. 7(2):45–52.

BUCKLEY, J. J. C. 1960. On *Brugia* gen. nov. for *Wuchereria* spp. of the '*malayi*' group, i.e. *W. malayi* Brug (1927), *W. pahangi* Buckley and Edeson, 1956, and *W. patei* Buckley, Nelson and Heisch, 1958. Ann. Trop. Med. and Parasitol. 54(1):75–77.

BURNETT, G. F. 1960. Filariasis research in Fiji 1957–1959. Part I. Epidemiology. Part II. Experiments in larval control of mosquito vectors. Trop. Med. and Hyg. (London) 63(7):153–162; 63(8):184–192. [To be concluded.]

BURTON, G. J. 1960. Studies on the bionomics of mosquito vectors which transmit filariasis in India. II. The role of water hyacinth (*Eichhornia speciosa* Kunth) as an important host plant in the life cycle of *Mansonia uniformis* (Theobald). With notes on the differentiation of the late embryonic and newly hatched stages of *Mansonia uniformis* (Theobald) and *Mansonia annulifera* (Theobald). III. Further studies on attachment of *Mansonia uniformis* larvae to host plants occurring in *Pistia* tanks in Kerala, South India. IV. Observations on larvivorous activities of various fishes in filarial areas of Kerala State, South India. Indian Jour. Malariol. 14(2):81–106; 107–129; 131–156.

CHAND, D., SINGH, M. V. and SHRIVASTAVA, R. N. 1959. Note on filariasis in Hardoi town, Uttar Pradesh. Indian Jour. Malariol. 13(4): 163–173.

DESPREZ, P. 1959. Une localisation rare de filariose oculaire à *Wuchereria bancrofti.* Premier cas malgache de présence de microfilaire de Bancroft dans la chambre antérieure de l'oeil. Med. Trop. (Marseilles) 19(6):687–691.

DIJK, W. J. O. M., VAN. 1959. The suitability of *A. koliensis* as an intermediate host for *W. bancrofti.* Trop. and Geog. Med. 11(3):259–262.

EDESON, J. F. B., WILSON, T., WHARTON, R. H. and LAING, A. B. G. 1960. Experimental transmission of *Brugia malayi* and *B. pahangi* to man. Roy. Soc. Trop. Med. and Hyg. Trans. 54(3):229–234.

FRIEDHEIM, E. A. H. and JONGH, R. T., DE 1959. L'effet du pentylthiarsaphénylmélamine (Mel W) sur *W. bancrofti.* Soc. de Path. Exot. Bul. 52(6):785–791.

HAHN, A. W. 1960. Angiocardiography in canine dirofilariasis. II. Utilization of a rapid film change technique. Amer. Vet. Med. Assoc. Jour. 136(8):355–358.

HASSAN, M. Y. B. 1959. The filariasis campaign in Kedah. Med. Jour. Malaya 14(1):36–46.

HAYASHI, S. 1959. Evaluation of the effects of diethylcarbamazine-treatments and antimosquito measures in the filariasis control studies based on the efficiency of the thick blood smear examinations. Jap. Jour. Parasitol. 8(6):904–908. In Jap., Engl. Sum.

———, SATO, K. and OSADA, Y. 1959. Studies on the *W. bancrofti* infection in Aogashima Island of the Izu Archipelago. Jap. Jour. Parasitol. 8 (6):895–903. In Jap., Engl. Sum.

HSIEH, S. C., LIU, YÜ-K'UN and LIU, J. 1960. Single dose hetrazan treatment of filariasis. Chinese Med. Jour. (Peking) 80(2):166–169.

IKESHOJI, T., SASA, M. and OSADA, Y. 1959. Observations on the effect of antimosquito measures in the control of filariasis in 1958. Jap. Jour. Sanit. Zool. 10(3):188–196. In Jap., Engl. Sum.

JORDAN, P. 1960. Effect of prednisolone in bancroftian elephantiasis. Brit. Med. Jour. 5178: 1020–1022.

JUNG, R. C. and HARRIS, F. H. 1960. Human filarial infection in Louisiana. Arch. Pathology 69(4):371–373.

KRISHNASWAMI, A. S., KRISHNAN, K. S., RAGHAVAN, N. G. S. and BHATNAGAR, V. N. 1959. Studies in transmission of filariasis. I. Effect of *D. repens* infection on the longevity of *Aedes aegypti*. Natl. Soc. India for Malaria and other Mosquito-Borne Dis. Bul. 7(3):95–101.

LAING, A. B. G., EDESON, J. F. B. and WHARTON, R. H. 1960. Studies on filariasis in Malaya: the vertebrate hosts of *Brugia malayi* and *B. pahangi*. Ann. Trop. Med. and Parasitol. 54(1): 92–99.

LAURENCE, B. R. and PESTER, F. R. N. 1960. Some aspects of the development of *Brugia patei*. Buckley, Nelson and Heisch in *Mansonia (Mansonioides) uniformis* Theo. Roy. Soc. Trop. Med. and Hyg. Trans. 54(1):3.

MCCARTHY, D. D. 1959. The endemicity of filariasis in the Pacific Island Dependencies of New Zealand. New Zealand Med. Jour. 58(328): 757–765.

———. 1959. Filariasis in the Cook Islands. New Zealand Med. Jour. 58(328):738–748.

NAIR, C. P. 1960. Problems connected with filariasis control in India. Kerala State Qualified Sanit. and Health Inspectors' (other than Govt. Servants) Ass. Souvenir. First Provincial Conference, Calicut 8 and 9 December 1959. pp. 53–55.

OMORI, N. and COWORKERS. 1959. Filaria control experiments in western Kyushu, Japan. Jap. Jour. Parasitol. 8(6):886–894. In Jap., Engl. Sum.

SASA, M. and COWORKERS. 1959. A review of field experiments in the control of bancroftian and malayan filariasis in Japan, 1958. Jap. Jour. Expt. Med. 29(5):369–405.

———. 1959. Studies on the control of *W. bancrofti* infection in Ehime. Jap. Jour. Parasitol. 8(6):880–885. In Jap., Engl. Sum.

———. 1959. Studies on the control of *Wuchereria bancrofti* infection in Amami Oshima Island. Jap. Jour. Parasitol. 8(6):872–879. In Jap., Engl. Sum.

SINHA, A. P., NANDA, D. K., SINGH, M. V. and CHAND, D. 1959. Day and night filaria surveys in some persons with periodic *W. bancrofti* before and after diethylcarbamazine therapy. Indian Jour. Malariol. 13(4):159–162.

WHARTON, R. H. 1960. Studies on filariasis in Malaya: field and laboratory investigations of the vectors of a rural strain of *Wuchereria bancrofti*. Ann. Trop. Med. and Parasitol. 54(1): 78–91.

WILLEMSE, J. J. 1959. *Culex fatigans* from New-Guinea and *Aedes polynesiensis* from Samoa as intermediate hosts of *Wuchereria bancrofti* (periodic form). Trop. and Geog. Med. 11(3): 237–245.

WU, Y. T. 1959. Filariasis and its control in Taiwan. Formosan Med. Assoc. Jour. 58(4): 228–238.

MALARIA

DRAPER, K. C. and DRAPER, C. C. 1960. Observations on the growth of African infants. With special reference to the effects of malaria control. Jour. Trop. Med. and Hyg. (London) 63(7):165–171.

DUKHANINA, N. N. and COWORKERS. 1960. Scientific session of the E. I. Martsinovsky Institute of Medical Parasitology and Tropical Medicine, Ministry of Public Health, USSR. Med. Parazit. i Parazit. Bolezni 29(3):370–377. In Rus. [Includes malaria.]

DUMITRESCO, V., POPESCO, G., OLINESCO, A. and CORIJESCO, V. 1959. Considérations sur l'activité antipaludique dans la République Populaire Romaine. Santé Pub. (Bucarest) 1(3/4): 113–132.

EAST AFRICA HIGH COMMISSION. 1960. Annual report of the East African Institute of Malaria and Vector-Borne Diseases, July 1958-June 1959, with a ten-year retrospect. 29 pp., Dar es Salaam. [D. Bagster Wilson, Director.]

GARNHAM, P. C. C. 1959. La ricerca del ciclo eso-eritrocitico nella malaria dei mammiferi. Ist. Super. di Sanità Rend. 22(11/12):1189–1199.

MUMFORD, E. P. 1960. The distribution of some parasites of man in the Near and Middle East. Jour. Trop. Med. and Hyg. (London) 63 (4):77–85.

NEMIROVSKAYA, A. I. 1960. Malaria and falciform anomaly of erythrocytes. Med. Parazit. i Parazit. Bolezni 29(4):474–481. In Rus.

OTSURU, M. 1960. Malaria studies in Japan after World War II. Part I. Epidemiological aspects of postwar malaria. Jap. Jour. Expt. Med. 30(1):23–32. In Engl.

——— and OHMORI, Y. 1960. Malaria studies in Japan after World War II. Part II. The research for *Anopheles sinensis* sibling species group. Jap. Jour. Expt. Med. 30(1):33–65. In Engl.

SHERMAN, I. W. and HULL, R. W. 1960. Serum alterations in avian malaria. Jour. Protozoology 7(2):171–176.

SINGH, JASWANT. 1959. (J. S. B.) stain—a review. Natl. Soc. India for Malaria and other Mosquito-Borne Dis. Bul. 7(3):79–94.

SMITH, A. and DRAPER, C. C. 1959. Malaria in the Taveta area of Kenya and Tanganyika. Part II. Results after three and a half year's treatment of huts with dieldrin. East Afr. Med. Jour. 36(12):629–643.

SOUTH PACIFIC COMMISSION. 1960. Fish pond mosquito breeding and malaria. S. Pacific Comm. Noumea, New Caledonia. Tech. Inform. Cir. 37:1–2.

VARGAS, L. and AMARAZ UGALDE, A. 1960. Observaciones sobre la epidemiologia del paludismo en México. Salud Pública México 2(1): 39–81.

WILSON, T. 1960. Sickling and malaria. Roy Soc. Trop. Med. and Hyg. Trans. 54(3): 283.

WORLD HEALTH ORGANIZATION. 1960. Malaria information. WHO Mal/Inform/62, 12 pp. [Includes health education in malaria campaigns.]

Malaria—Clinical Aspects

BLACK, R. R. H. 1959. Clinical features of overt *vivax* malaria seen in Australia: infections acquired in New Guinea. Med. Jour. Austral. 2(17):591–593.

COVELL, G. 1960. Relationship between malarial parasitaemia and symptoms of the disease. A review of the literature. WHO Bul. 22(6): 605–619.

DRAPER, C. C. 1960. Effect of malaria control on haemoglobin levels. Brit. Med. Jour. 5184: 1480–1483.

ENDOZIEN, J. C., BOYO, A. E. and MORLEY, D. C. 1960. The relationship of serum gammaglobulin concentration to malaria and sickling. Jour. Clin. Path. 13(2):118–123.

PETERS, W. 1959. Liver enlargement and malaria in New Guinea. Trop. and Geog. Med. 11(3):219–222.

———. 1960. Studies on the epidemiology of malaria in New Guinea. Part I. Holoendemic malaria—the clinical picture. Roy. Soc. Trop. Med. and Hyg. Trans. 54(3):242–249.

Malaria—Eradication

ALMAZOVA, V. V., RAZUMOVA, E. P. and LARINA, M. P. 1960. Ways of malaria eradication in Kazakhstan. Communication I. Malaria disease incidence in Kokchetav Oblast and means of its liquidation. Med. Parazit. i Parazit. Bolezni 29(4):391–398. In Rus., Engl. Sum.

ALVAREZ AMÉZQUITA, J. 1959. La erradicación de paludismo en México. CNEP Bol. 3(3): 3–17. Engl. Sum.

BRITISH MEDICAL JOURNAL. 1960. Eradication of malaria. Brit. Med. Jour. 5178:1033–1034.

BRUCE-CHWATT, L. J. 1960. Eradication of malaria. Brit. Med. Jour. 5192:150.

CABRERA PALMA, N. DE J. 1959. Barreras de protección urbana en la erradicación del paludismo. CNEP Bol. (México) 3(4):8–26. Engl. Sum.

GÓMEZ MENDOZA, I. 1959. La evaluación epidemiológica en la campaña de erradicación del paludismo en México. CNEP Bol. (México) 3 (2):11–18.

MACDONALD, G. 1959. L'eradicazione della malaria. Ist. Super. di Sanità Rend. 22(11/12): 1200–1211.

RADACOVICI, E. and COWORKERS. 1959. Contributii la studiul malariei in zona bazinului hidrografic al Rîului Ialomit. Microbiol., Parazitol., Epidemiol. (Bucarest) 4(3):241–249.

WORLD HEALTH ORGANIZATION. 1960. Thirteenth World Health Assembly, Geneva, 3–20 May 1960. Part I. Resolutions and decisions. Annexes. WHO Off. Rec. No. 102, 105 pp. [Includes malaria eradication special account pp. 72–77.]

Malaria—Plasmodia

BENNETT, G. F. and FALLIS, A. M. 1960. Blood parasites of birds in Algonquin Park, Canada, and a discussion of their transmission. Canad. Jour. Zool. 38(2):261–273.

BOUISSET, L. and RUFFIE, J. 1960. L'adaptation biologique du parasite à l'hôte. Méd. Afrique Noire (Dakar) 7(5):89–92.

DUNCAN, D. STREET, J., JULIAN, S. R. and MICKS, D. O. 1959. Electron microscopic observations of the gametocytes of a malarial parasite (*Plasmodium cathemerium*). Texas Rpts. on Biol. and Med. 17(3):314–322.

HOWARD, L. M. 1960. The mechanism of infection of the mosquito by the malaria parasite. Johns Hopkins Hosp. Bul. 106(1):55.

LAIRD, M. 1960. Migratory birds and the dispersal of avian malaria parasites in the South Pacific. Canad. Jour. Zool. 38(1):153–155.

SHUTE, P. G. 1960. Quiescent malaria parasites. Brit. Med. Jour. 5174–730–731.

TERZIAN, L. A. and STAHLER, N. 1960. Some inorganic acids, bases and salts as determinants of innate immunity in the mosquito. Jour. Infect. Dis. 106(1):45–52.

TRAGER, W. 1959. A new virus of ducks interfering with development of malaria parasite (*Plasmodium lophurae*). Soc. Expt. Biol. and Med. Proc. 101(3):578–582.

WALTERS, J. 1960. Quiescent malarial parasites. Brit. Med. Jour. 5180:1206–1207.

ZUCKERMAN, A. 1960. Auto-antibody in rats with *Plasmodium berghei*. Nature (London) 185(4707):189–190.

———. 1960. Blood loss and replacement in plasmodial infections. III. *Plasmodium cynomolgi, Plasmodium gonderi* and *Plasmodium knowlesi* in *Macaca mulatta mulatta,* the rhesus monkey. Jour. Infect. Dis. 106(2):123–140.

Malaria—Therapeutics and Antimalarials

ALVING, A. S. and COWORKERS. 1960. Mitigation of the haemolytic effect of primaquine and enhancement of its action against exoerythrocytic forms of the Chesson strain of *Plasmodium vivax* by intermittent regimens of drug administration. A preliminary report. WHO Bul. 22(6):621–631.

ARCHIBALD, H. M. and ROSS, C. M. 1960. A preliminary report on the effect of diaminodiphenyl sulphone on malaria in Northern Nigeria. Jour. Trop. Med. and Hyg. (London) 63(2):25–27.

BURGESS, R. W. and BRAY, R. S. 1960. The effect of a single dose of primaquine upon the gametocytes, gametogony and sporogony of *Laverania* (= *Plasmodium*) *falciparum*. WHO/Mal/271, 9 pp.

CHIN, Y. C. and COWORKERS. 1960. Antimalarial properties of some guanidine derivatives. Nature (London) 186(4819):170–171.

GAUDETTE, L. E. and COATNEY, G. R. 1960. Stability of primaquine diphosphate under various conditions. Amer. Jour. Trop. Med. and Hyg. 9(5):532–535.

HALLINAN, T. C. 1959. Drug resistance in malaria. West Indian Med. Jour. 8(2):132–134.

LYSENKO, A. YA. 1960. Use of quinocide in treatment and prophylaxis of vivax malaria. WHO Bul. 22(6):641–662.

SCALES, W. T. H. 1960. Corneal changes during therapy with an antimalarial drug, "Camoquin". Med. Jour. Austral. 1(8):294–295.

VARGAS, L. 1959. Prevencion y tratamiento del paludismo. Presna Med. Mexicana 23(1): 1–10.

Malaria—Vectors

O'GOWER, A. K. 1960. Townsville culicines as possible vectors of dengue and allied viruses among local feral fauna. Austral. Jour. Expt. Biol. and Med. Sci. 38(1):1–10.

OTHER DISEASES

DARLINGTON, C. D. 1960. Symposium on the evolution of arborvirus diseases. I. Origin and evolution of viruses. Roy. Soc. Trop. Med. and Hyg. Trans. 54(2):89–96.

FENNER, F. 1959. Myxomatosis. Brit. Med. Bul. 15(3):240–245.

———. 1959. Myxomatosis in Australian wild rabbits—evolutionary changes in an infectious disease. The Harvey Lectures, Ser. 53: 25–55.

GORDON SMITH, C. E. 1960. Symposium on the evolution of arborvirus diseases. III. Factor in the past and future evolution of arborviruses. Roy. Soc. Trop. Med. and Hyg. Trans. 54(2): 113–129.

KOMAROV, A. and KALMAR, E. 1959. A hitherto undescribed virus disease-turkey encephalitis. Bul. Res. Council Israel E 8E (1/2):64. [*A. aegypti.*]

NYE, E. R. and LIEN, J. C. 1960. Laboratory transmission of Semliki Forest virus by *Aedes togoi.* Roy. Soc. Trop. Med. and Hyg. Trans. 54(3):263–264.

SERGENT, ED. and PARROT, L. 1959. Disparition de la fiévre bilieuse hémoglobinurique en Algérie. Soc. de Path. Exot. Bul. 52(1):42–47. [Also in Inst. Pasteur d'Algérie Arch. 37(2): 256–262, 1959.]

SMITHBURN, K. C., PATERSON, H. E., HEYMANN, C. E. and WINTER, P. A. D. 1959. An agent related to Uganda S virus from man and mosquitoes in South Africa. South Afr. Med. Jour. 33(46):959–962. [*Culex rubinotus, C. univittatus.*]

SOPER, F. L. 1960. La erradicación y el control en la prevención de enfermedades transmisibles. Bol. Ofic. Sanit. Panamer. 49(2):121–131.

LITERATURE REFERENCES AND REVIEWS

IYENGAR, M. O. T. 1959. A review of the literature on the distribution and epidemiology of filariasis in the South Pacific Region. South Pacific Comm. (Noumea, New Caledonia) Tech. Pap. No. 126, 172 pp.

———. 1959. Supplement to annoted bibliography on filariasis and elephantiasis. Part 3. Symptomatology, aetiology, pathology and diagnosis of filariasis due to *Wuchereria bancrofti* and *W. malayi.* South Pacific Comm. (Noumea, New Caledonia) Tech. Pap. No. 109 (Suppl. No. 1), 25 pp.

WILCOCKS. 1960. Summary of recent abstracts. III. Malaria. VII. Helminthiasis. Trop. Dis. Bul. 57(4):325–335; 57(9):869–880. [VII includes filariasis.]

SUBJECTS NOT COVERED BY OTHER HEADINGS

CALIFORNIA MOSQUITO CONTROL ASSOCIATION. 1960. Twenty-eighth annual conference. Calif. Mosquito Cont. Assoc. Proc. 28, 108 pp., Visalia, Calif.

FLORIDA ANTI-MOSQUITO ASSOCIATION. 1960. Report of the thirty-first annual meeting. 117 pp., Tampa, Fla.

GRANT, C. D. 1960. Research in California vector control. Calif. Mosquito Cont. Assoc. Proc. 28:16–17.

KLEINMAN, D. S. 1960. Classification survey of local mosquito control agencies. Calif. Mosquito Cont. Assoc. Proc. 28:22–24.

MAZOKHIN-PORSHNYAKOV, G. A. 1960. Why insects fly to light by night. Ent. Obozr. 39(1): 52–58. In Rus., Engl. Sum.

MCFARLAND, G. C. 1960. Position and salary surveys and evaluation for mosquito abatement districts. Calif. Mosquito Cont. Assoc. Proc. 28: 19–21.

MURRAY, W. D. 1960. CMCA survey of personnel and working conditions. Calif. Mosquito Cont. Assoc. Proc. 28:24–26.

PISTEY, W. R. 1959. Studies on the mortality of mosquitoes infected with *Dirofilaria tenuis* Chandler 1942. Expt. Parasitol. 8(6):596–608.

ERRATA

In Mosquito News 19(2):132, under Genetics section change pages of reference by Frizzi and Kitzmiller to read 33–38; 20(1):77, under Taxonomy section change rickenbach*ii* to read rickenbach*i* in reference to Hamon and Adam; 20(1):80, under Malaria—Plasmodia section change page of Bray reference to read 679–680; 20(3):332, under Behavior, Biology and Ecology section change volume number to read 61 in reference by Lambrecht and Zaghi; 20(3):335, under Filariasis section insert name of periodical: Jour. Trop. Med. and Hyg. (London) in reference by Symes.